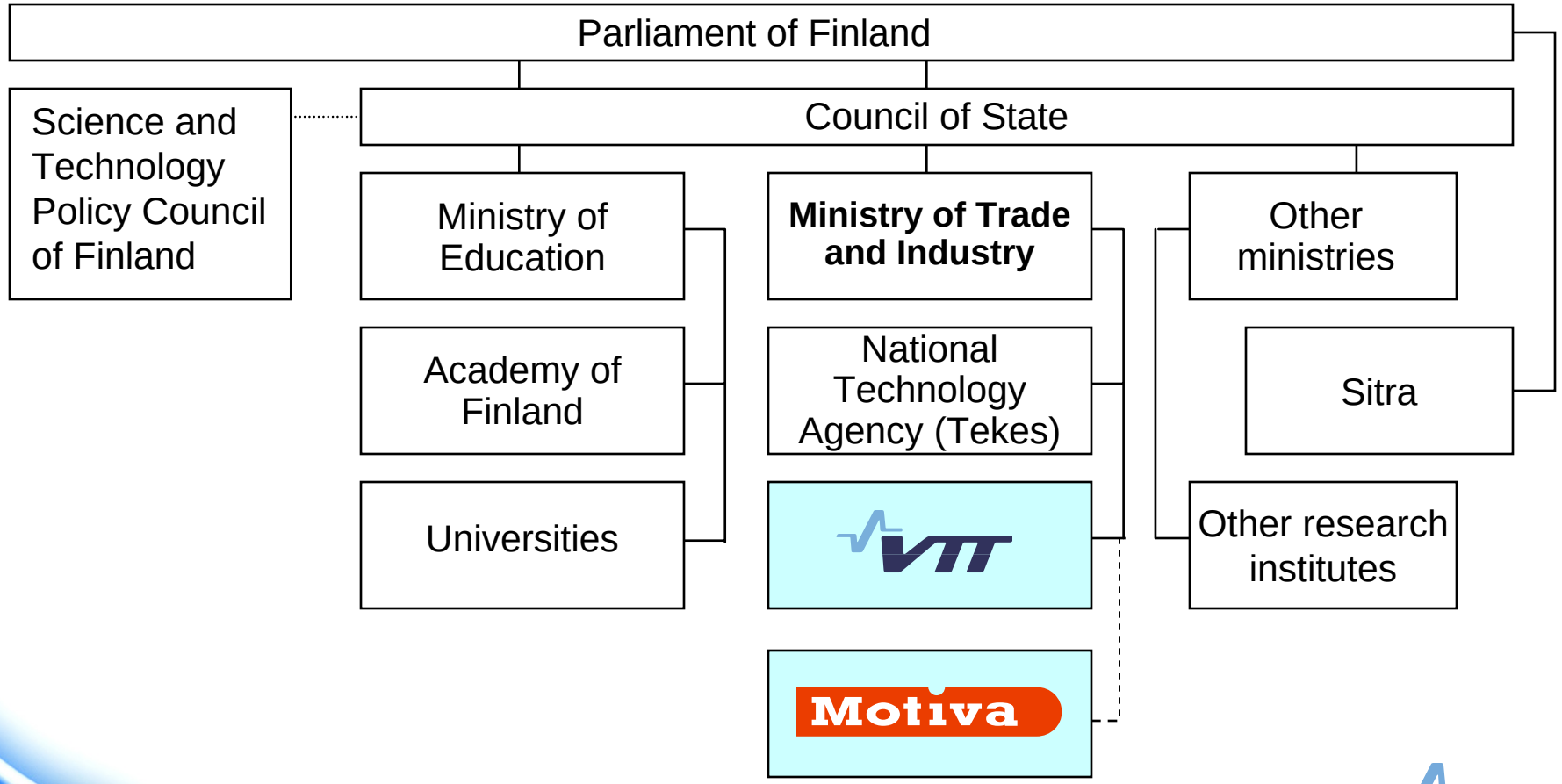
Energy Assessment and Analysis Methodology

"Energy Assessment Guide for Energy Managers and ESCOs"

Overview of the Subtask A Scope

Jorma Pietiläinen

THE MOST IMPORTANT DECISION MAKERS, FINANCERS AND PERFORMERS OF RESEARCH IN THE PUBLIC SECTOR



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VTT IN BRIEF

Units:

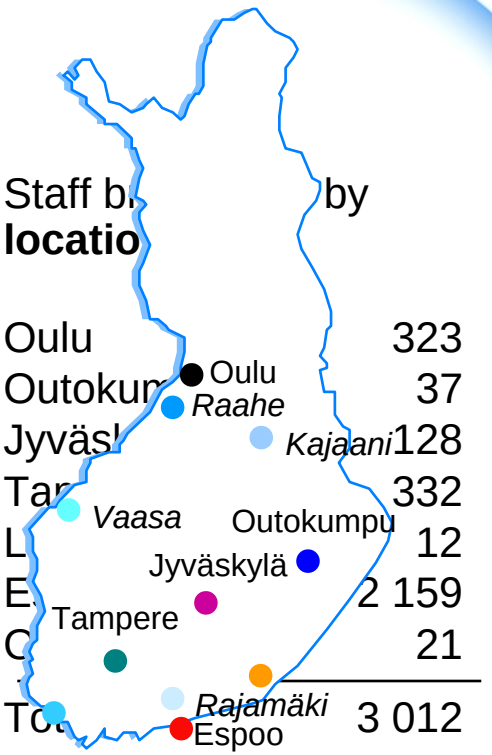
VTT Electronics
VTT Information Technology
VTT Industrial Systems
VTT Processes
VTT Biotechnology
VTT Building and Transport

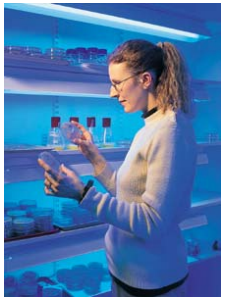
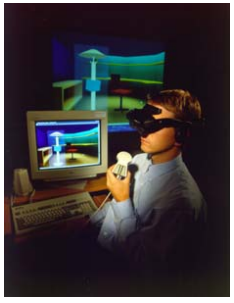
VTT Information Service
VTT Corporate Management and Services

Staff: 3 012

Turnover: 214 M€

- Basic govern. funding to R&D on VTT's own initiative 34 M€
- Jointly funded projects 92 M€
- Commercial activities 88 M€

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Objectives of Annex46

- **To provide tools and guidelines** for decisionmakers and energy managers, performance contractors and designers
- To improve the working environment
- To provide **recommendations on how to operate** the retrofitted buildings
- To promote energy- and cost-efficient retrofit measures by **providing successful examples**
- To support decisionmakers in **evaluating the efficiency** and acceptance of available concepts
- To find improved ways of using Energy Performance Contracts (ESPCs) for Government buildings retrofit measures

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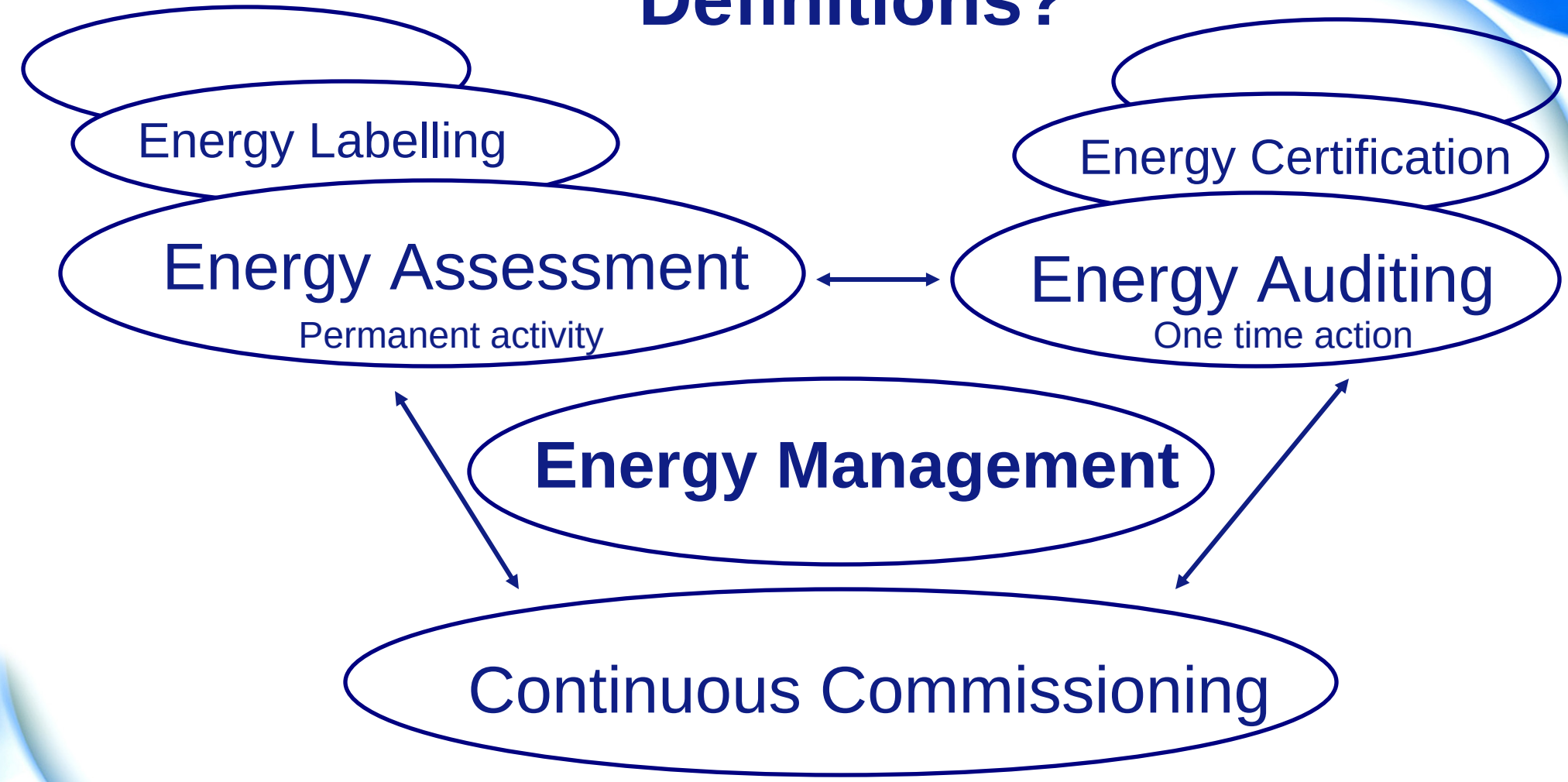
Definitions?



- IEA Annex4x: Cost-Effective Commissioning for Existing and Low Energy Buildings

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Focus of Subtask A

- Energy Assessment in Government non-residential buildings ≈ Energy Auditing?

- EA-Tools for decision making process of energy retrofitting ≈ Energy Management tools?

  - common procedures and guides

  - common software and other tools

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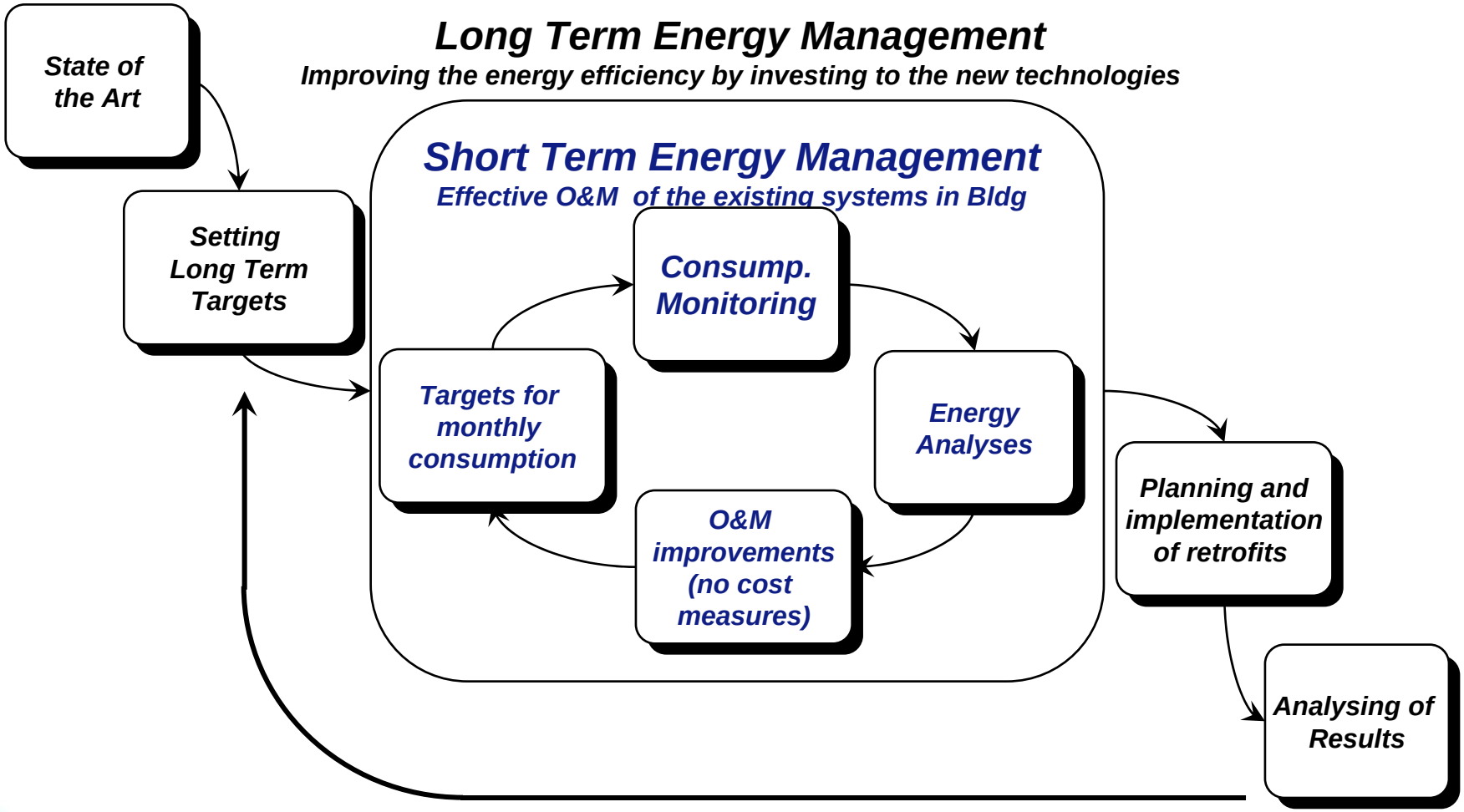
Enegy Management Strategies



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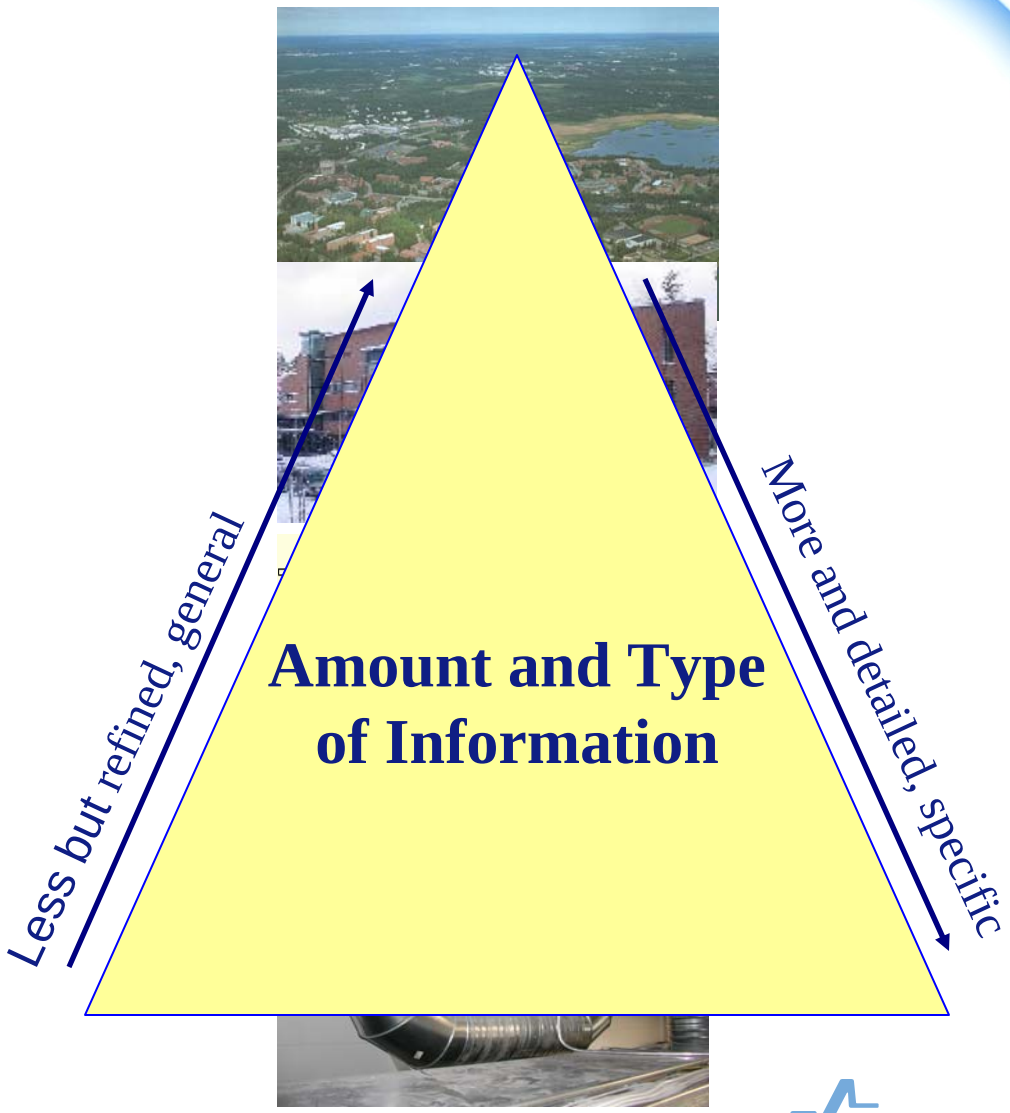
Different levels of EA

1. Building stock

2. Building

3. System

4. Component



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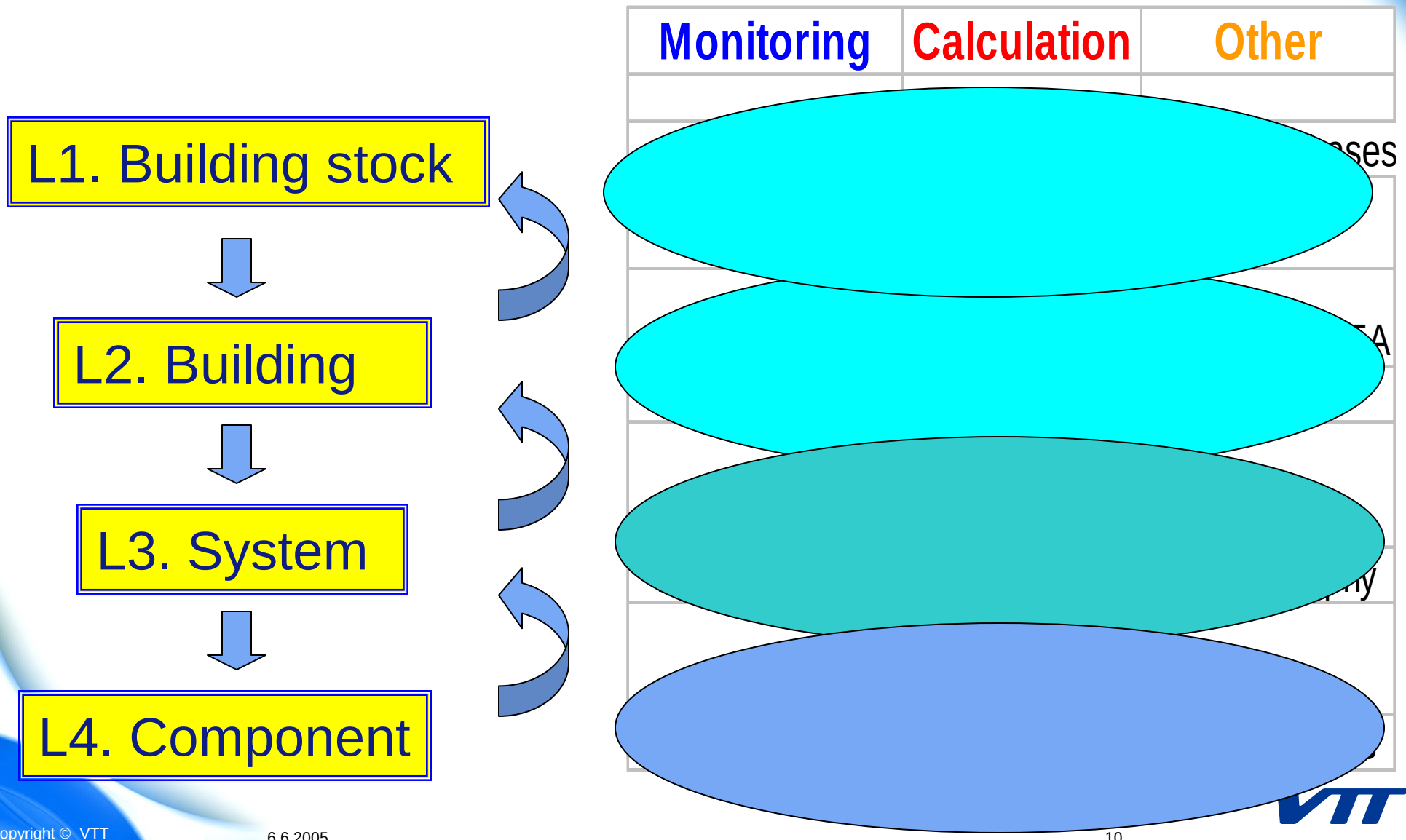
Some typical risks in EA

- Lack of wholeness and general view
- Instead of big picture focus only on some systems or equipments
- Suboptimisation

- We don´t see the wood for the trees or buildigstock/buildings for the gadgets

Tools of EA:



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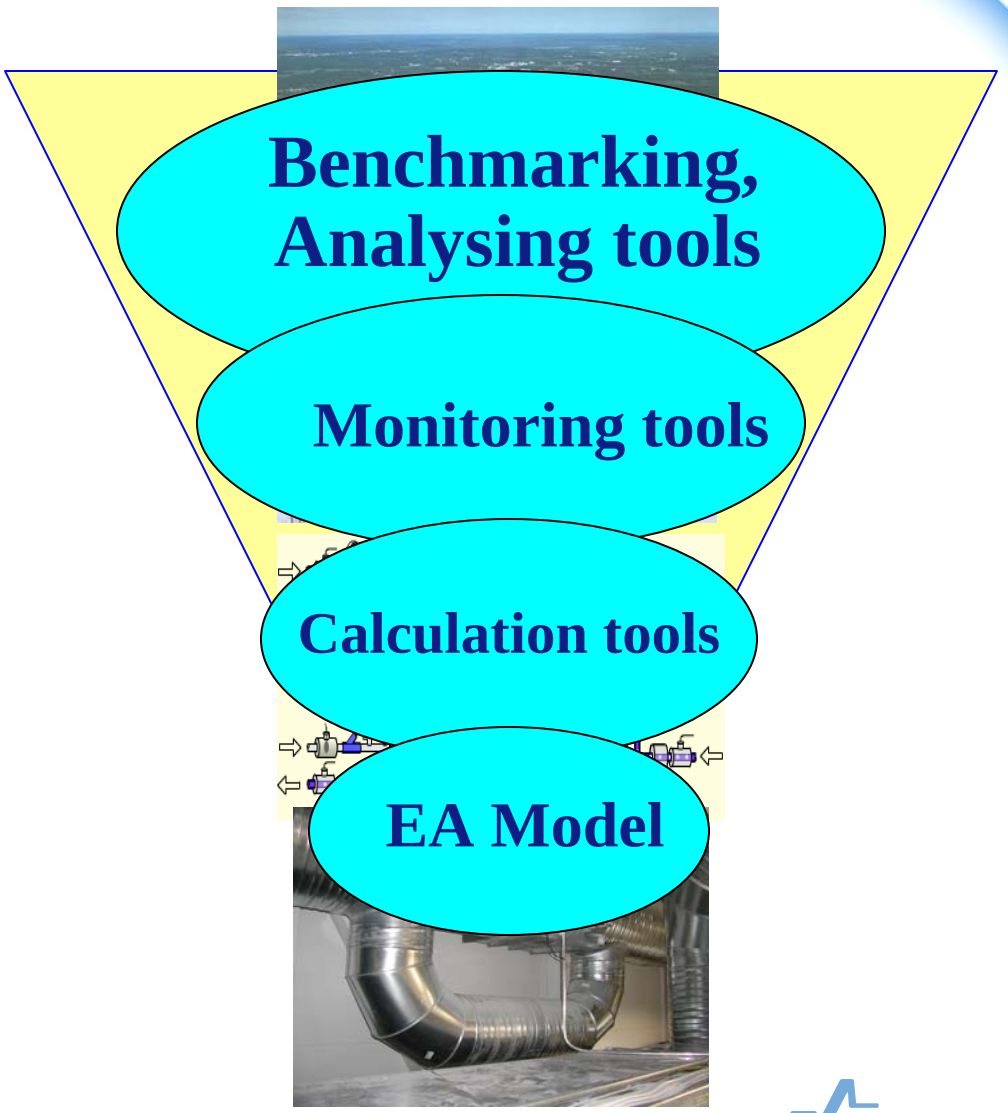
Focus of EA (Subtask A):

1. Building stock

2. Building

3. System

4. Component



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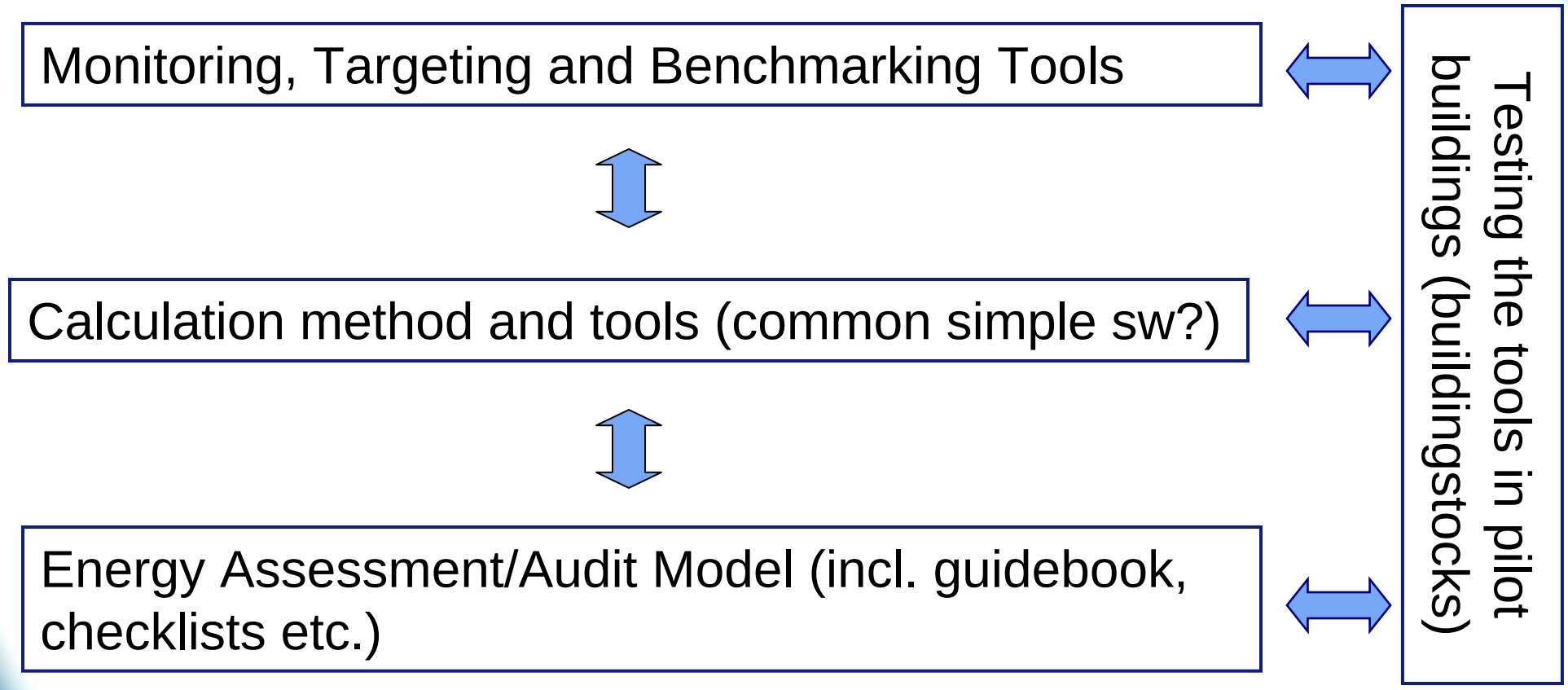
Focus of subtask A



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Tasks

A1 Mapping out useful existing materials and experiences
Analysing of present tools and (best) practicies

A2 Developing a www-based monitoring&targeting platform for EA
Setting up a pilot benchmarking sytem (incl pilot bldg-stocks)

A3 Developing simple calculation toolset for EA
(Testing it in pilot audits in pilot buildings?)

A4 Developing a common EA model incl. guidebook
(Testing it = Implementing pilot audits in pilot buildings?)

A5 Integrating the outputs with the other subtasks (especially D)
Reporting and dissemination activities

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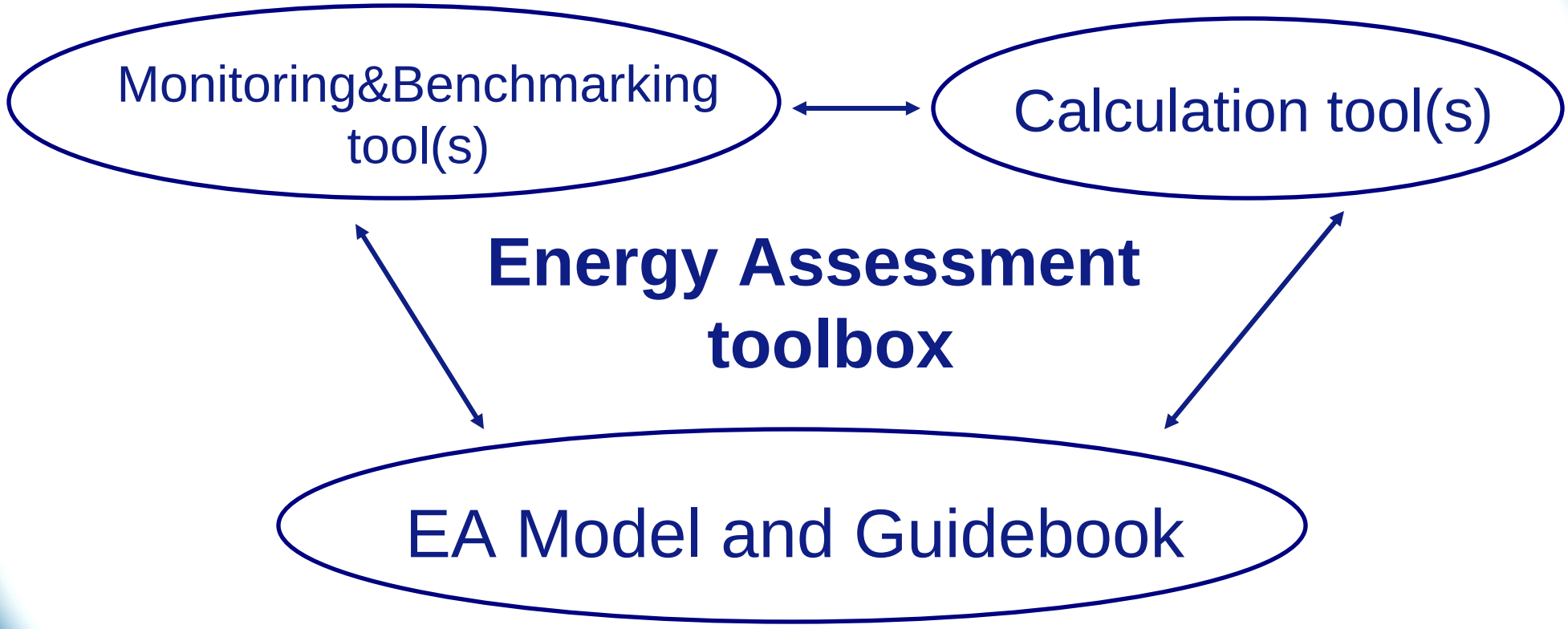
Subtask A Delivarables?



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Working Principle

We **don´t** have to

- **start from scratch!**
- **re-invent the wheel!**

A lot of knowledge and experience is available!

Some examples:

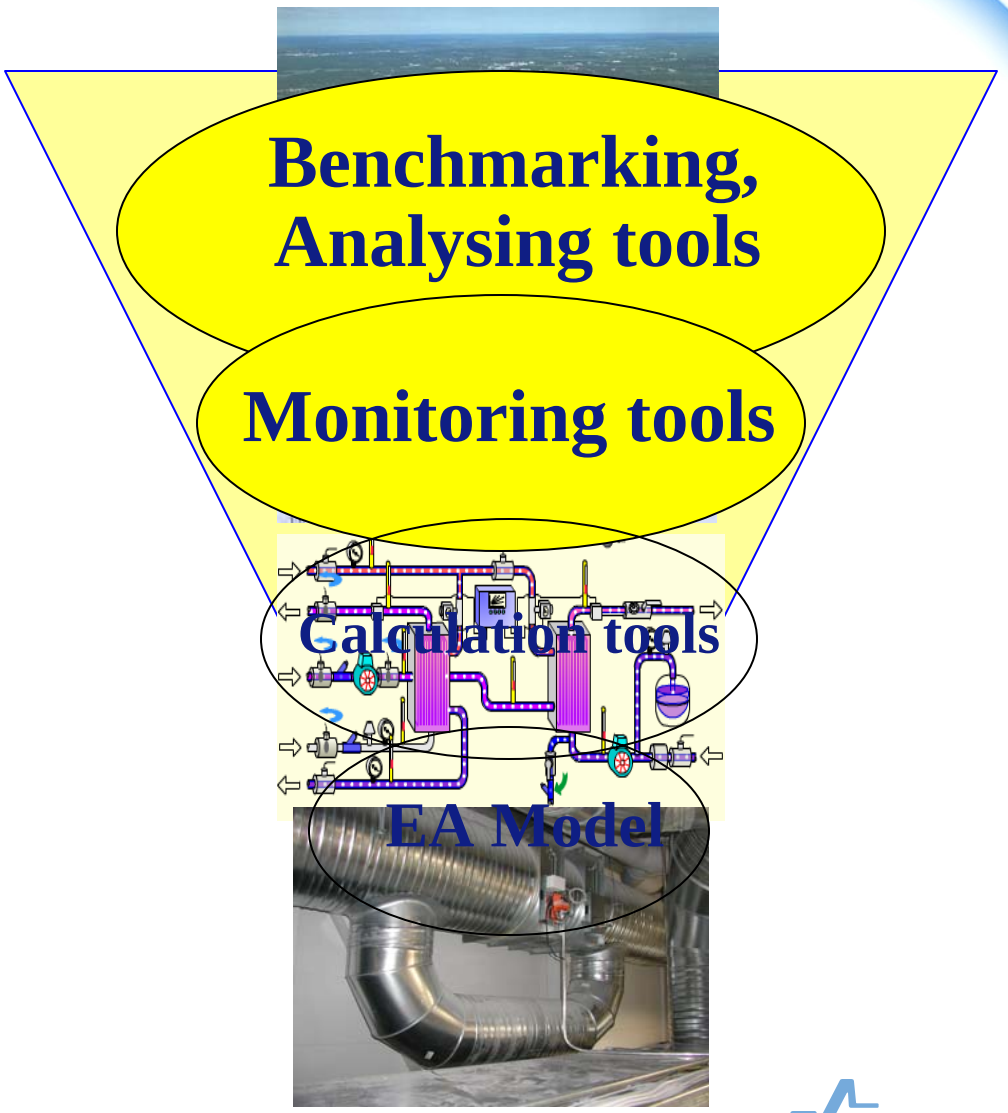
Examples of EA Tools:

1. Building stock

2. Building

3. System

4. Component



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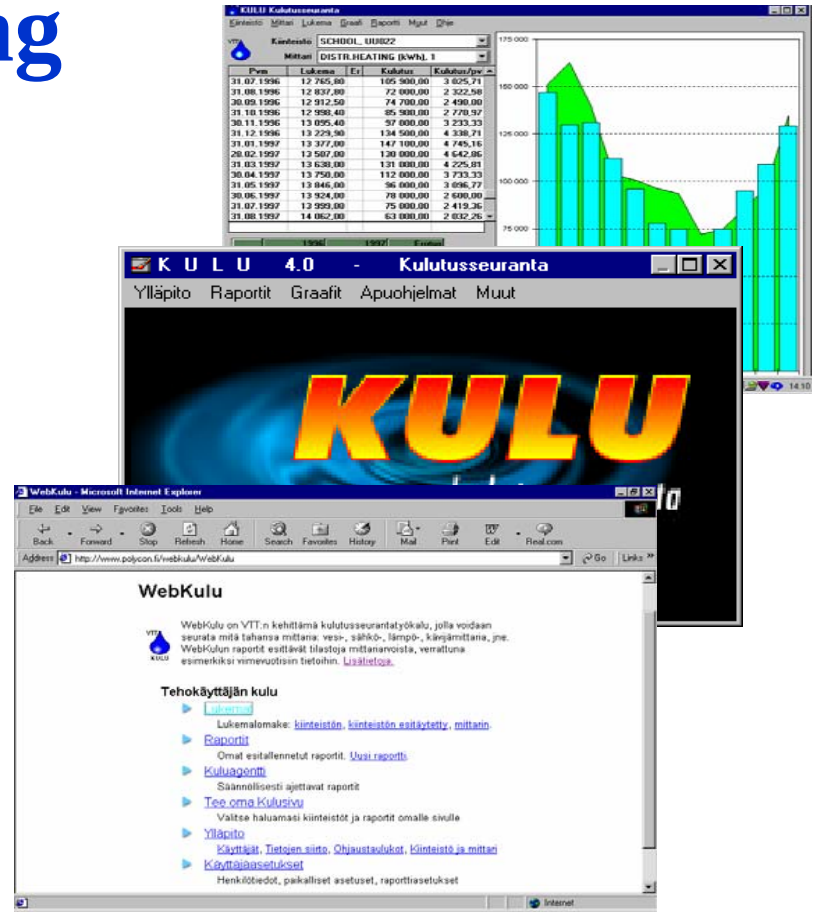
Motoring tools developed at VTT:

- ⇨Monitoring&Targeting
- ⇨Energy Management
- ⇨Analysing
- ⇨Benchmarking
- ⇨Feedback
- ⇨Motivation



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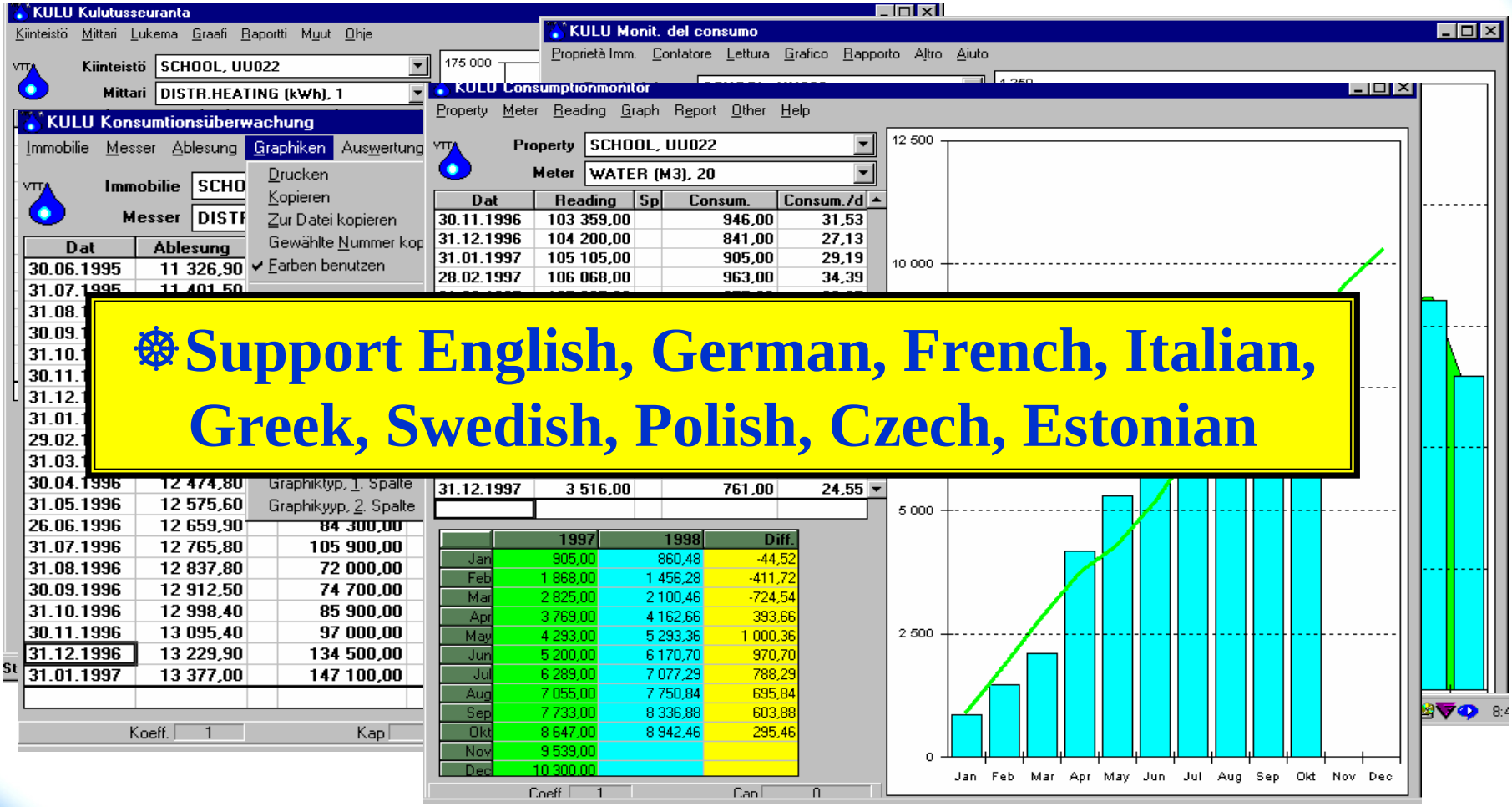

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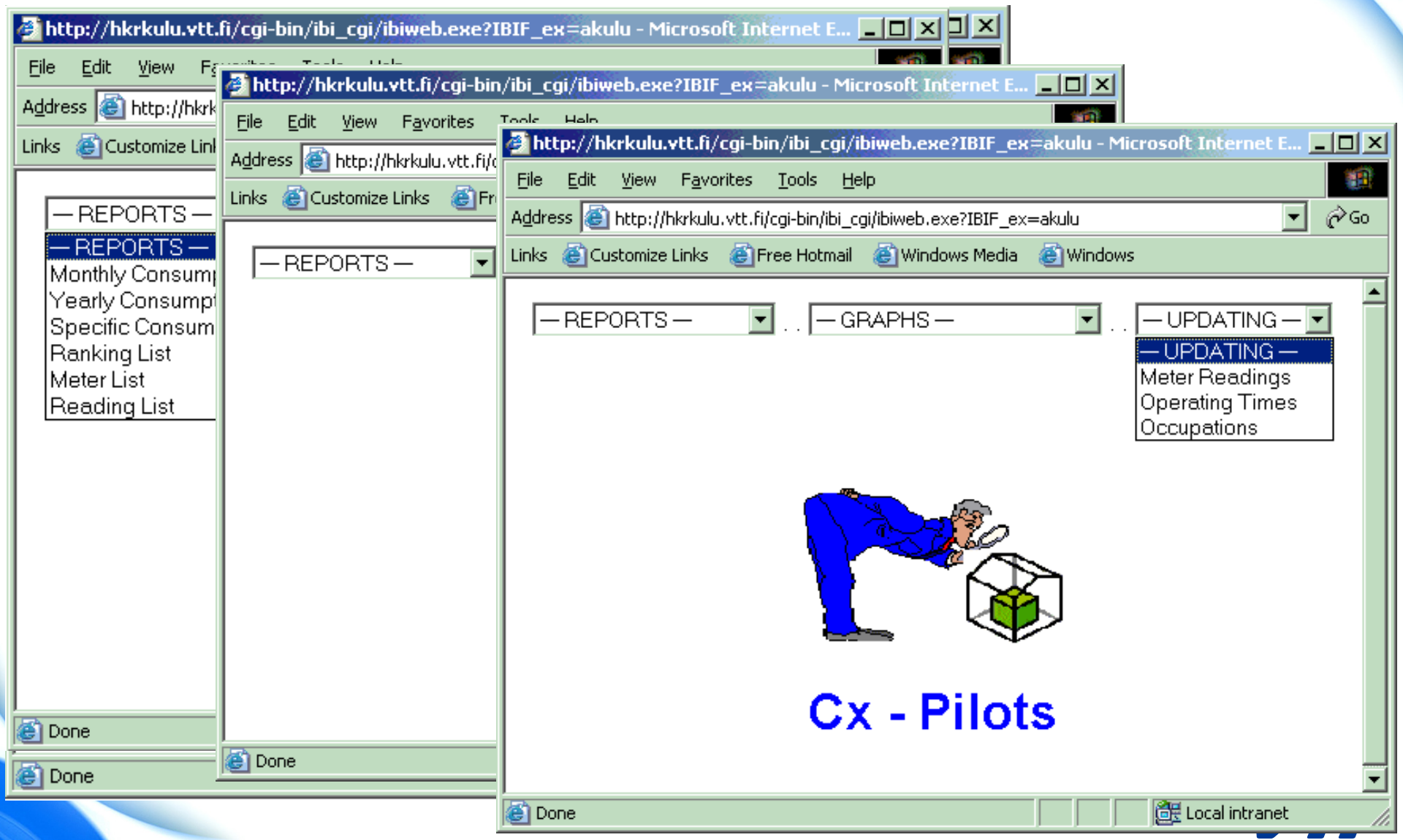

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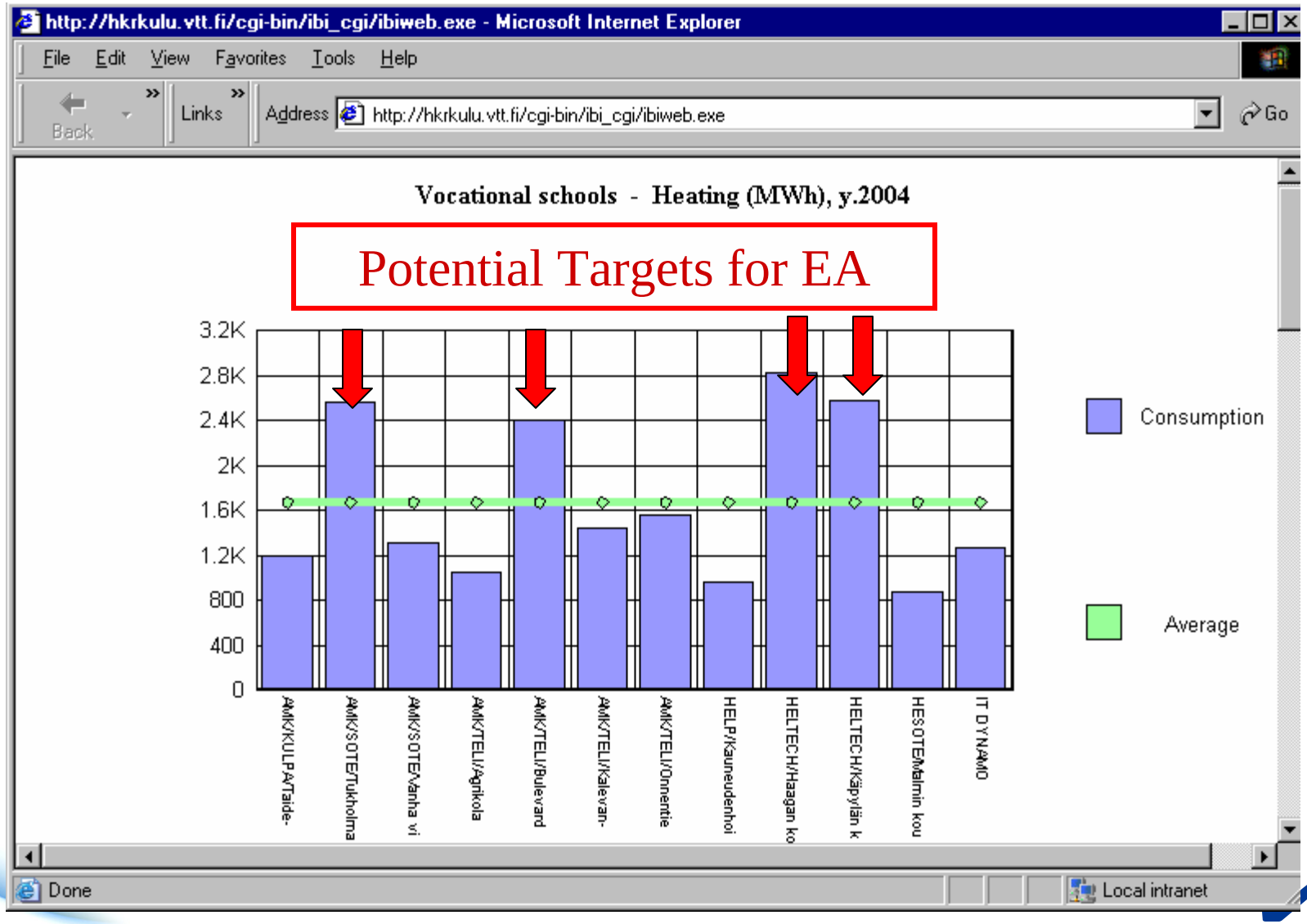
EA on Building Stock Level:



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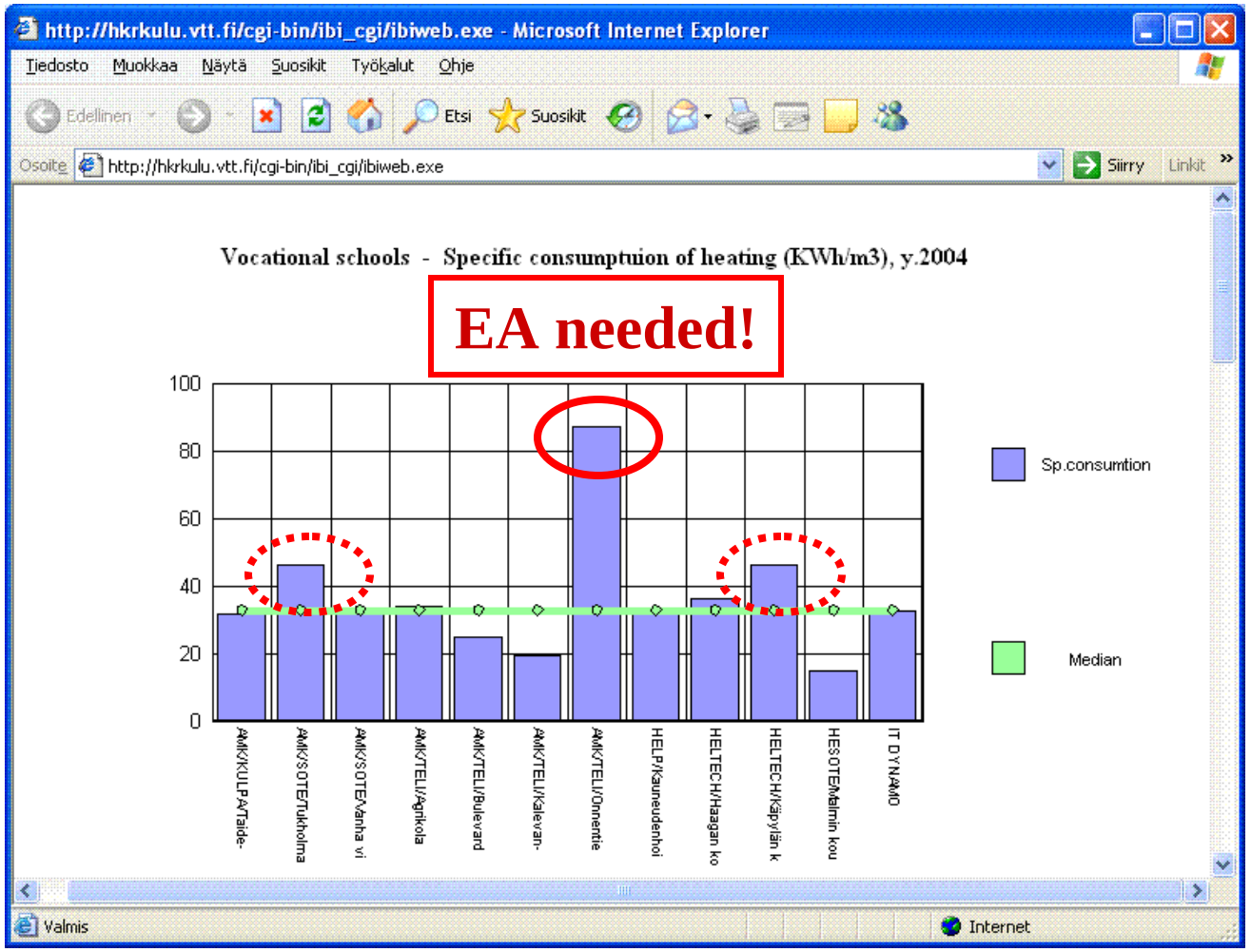
EA on Building Stock Level:



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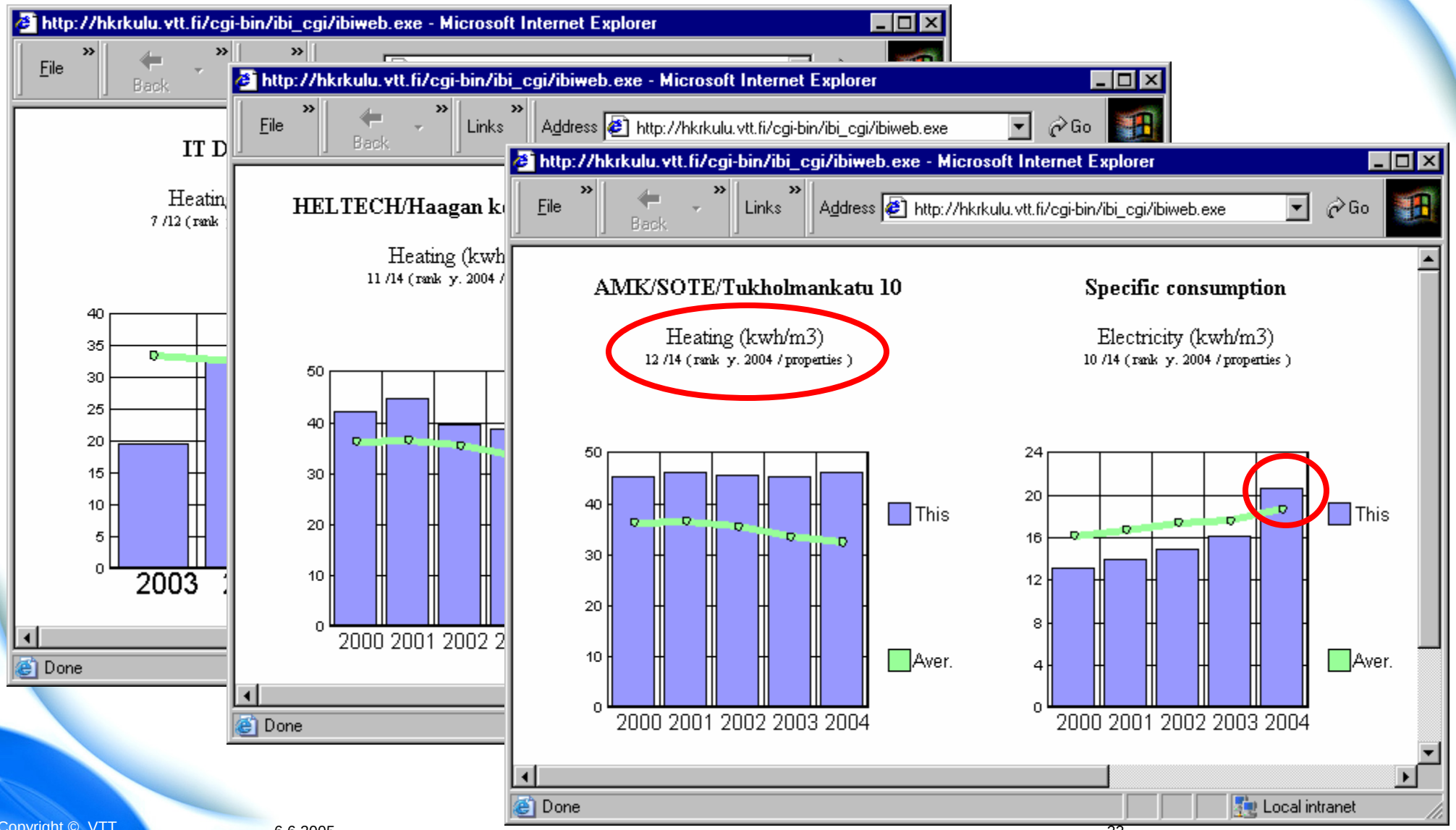

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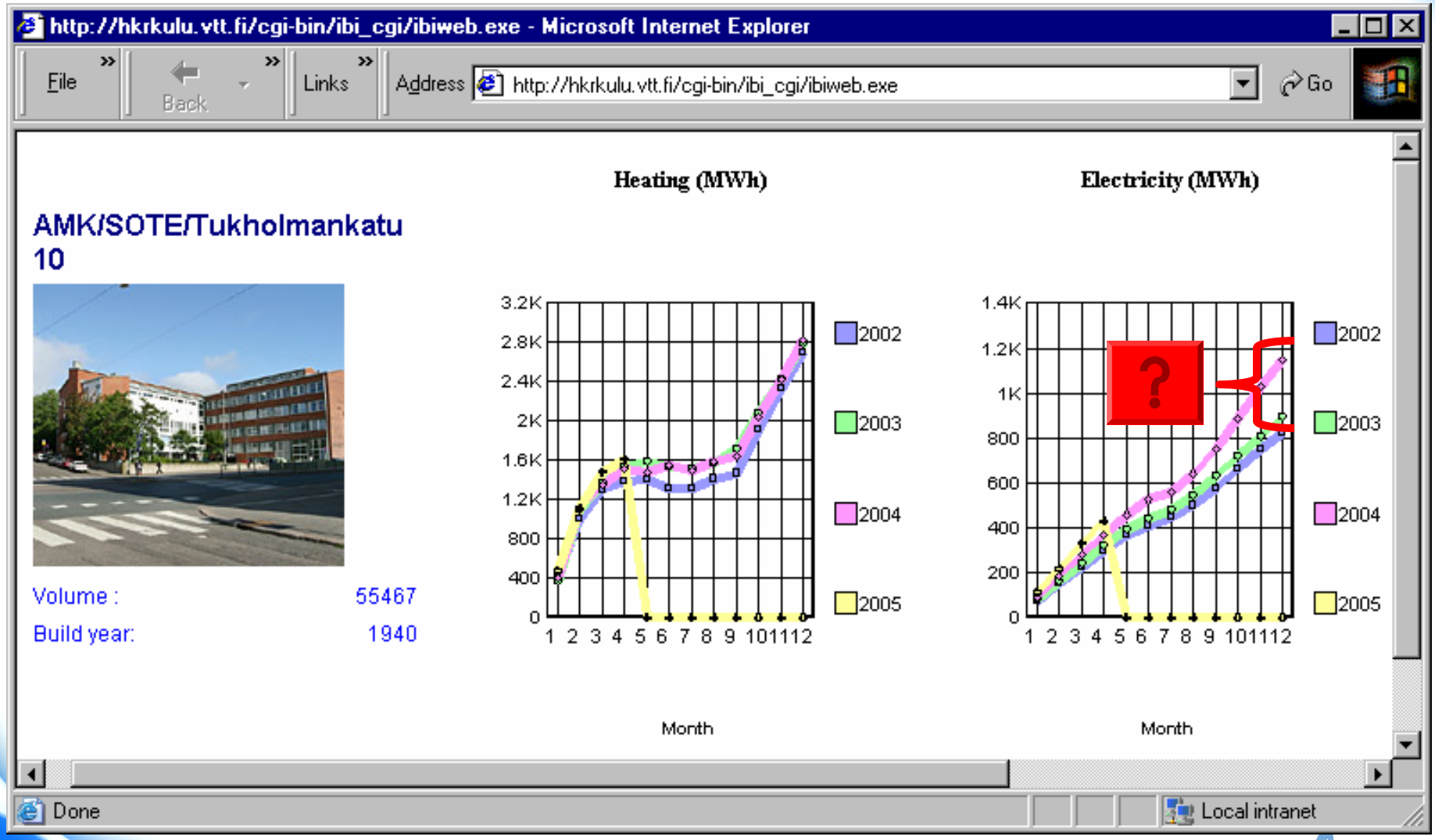

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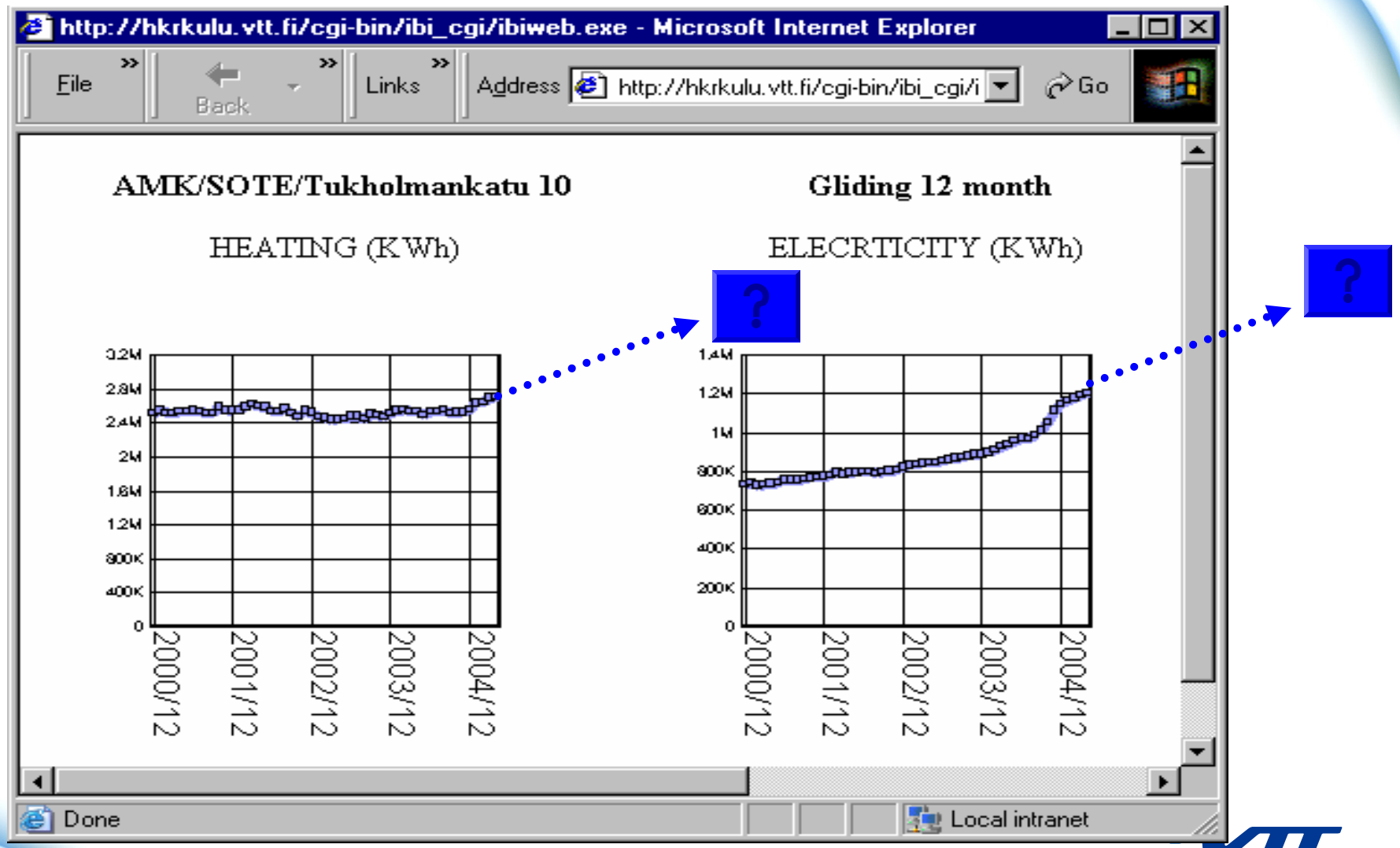

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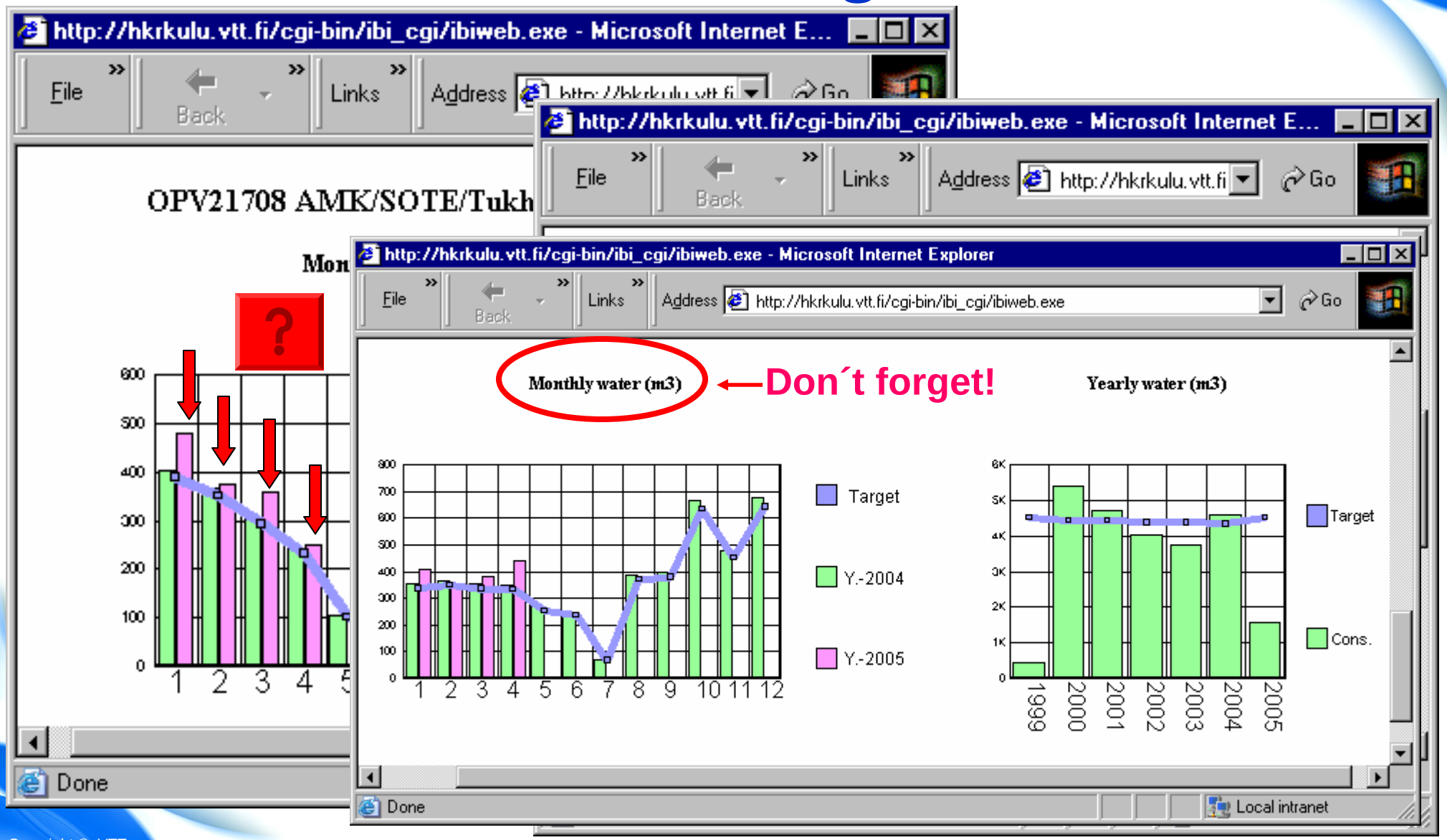

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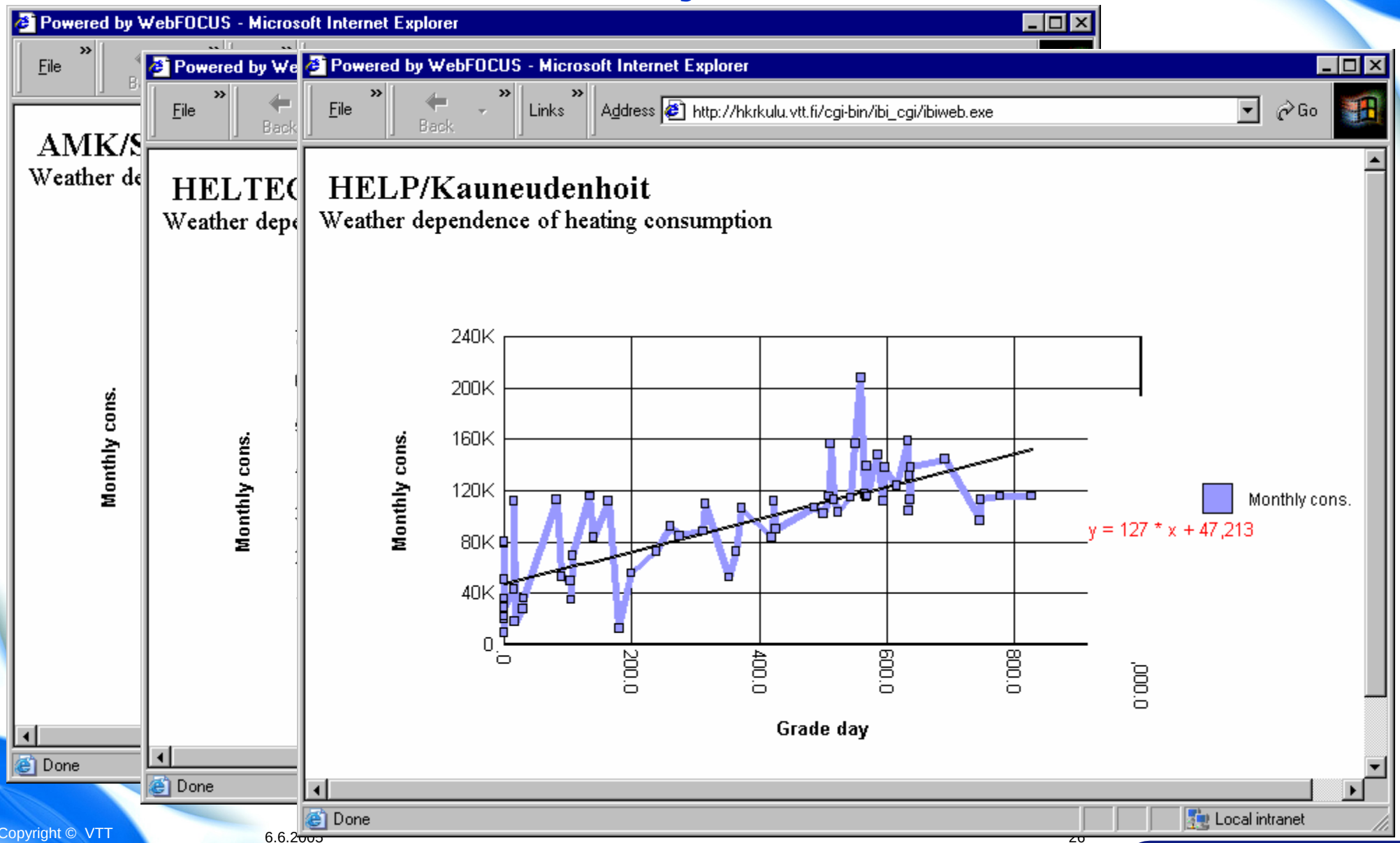
EA on System Level:



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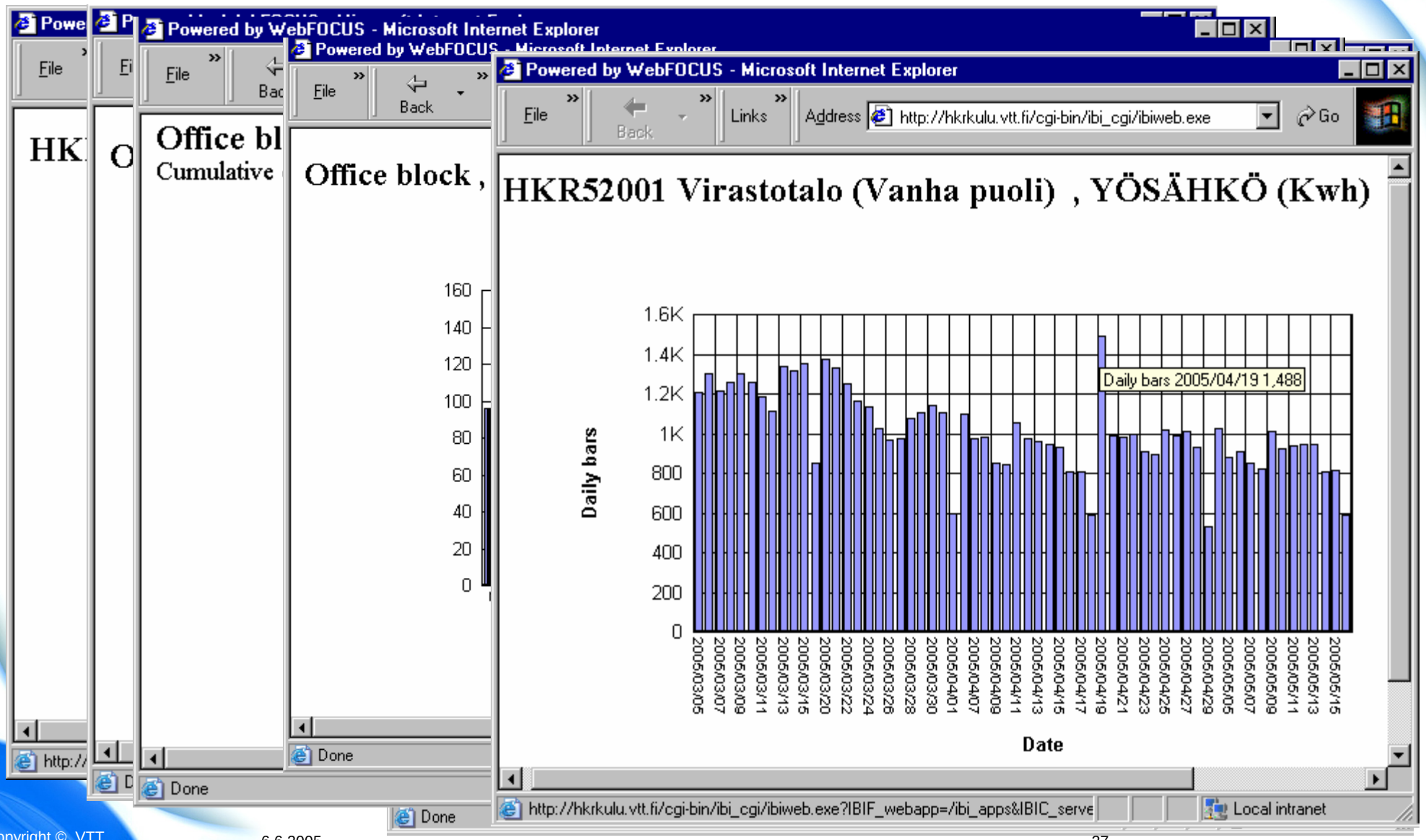

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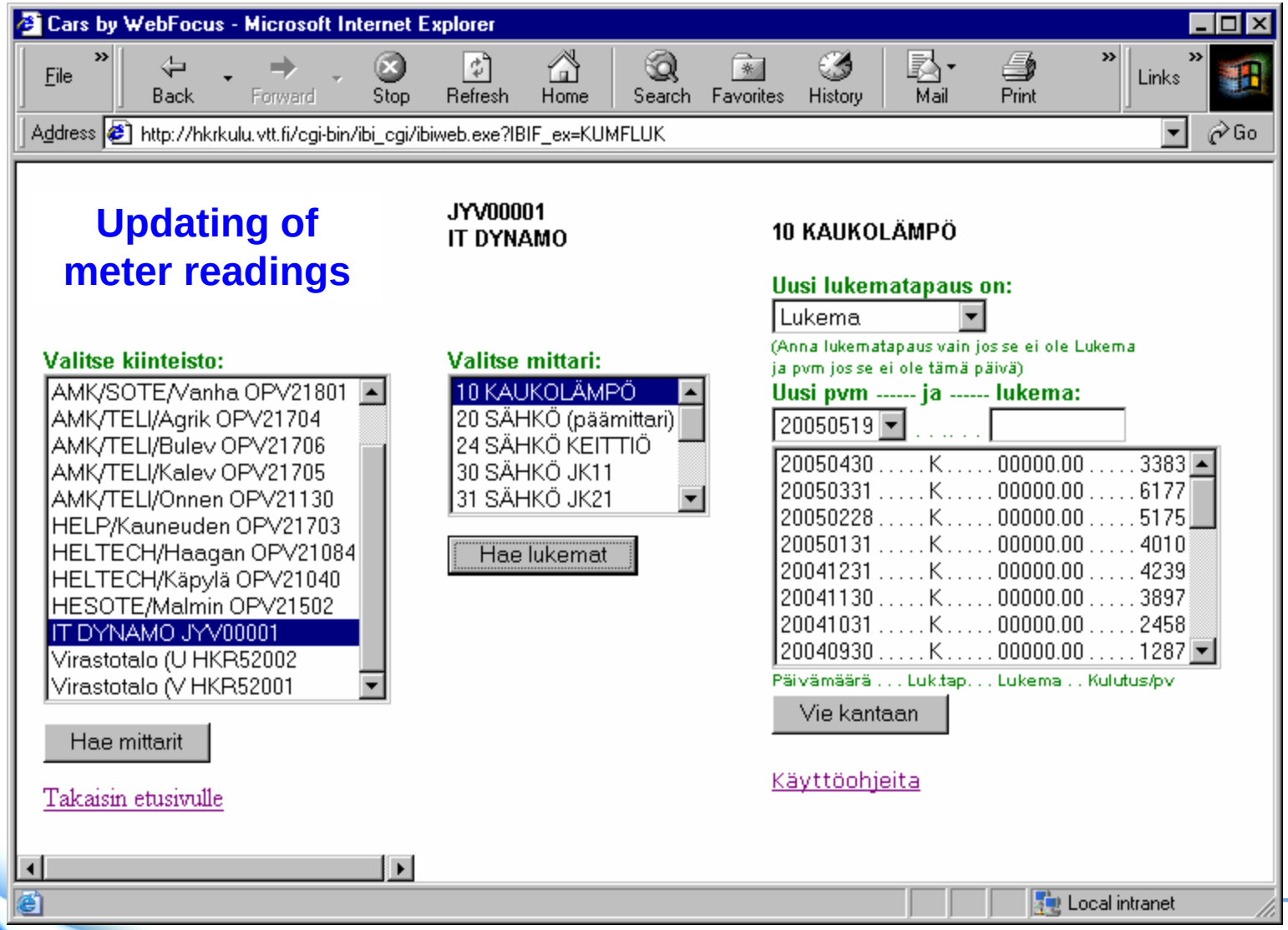
Simple tools for data collection



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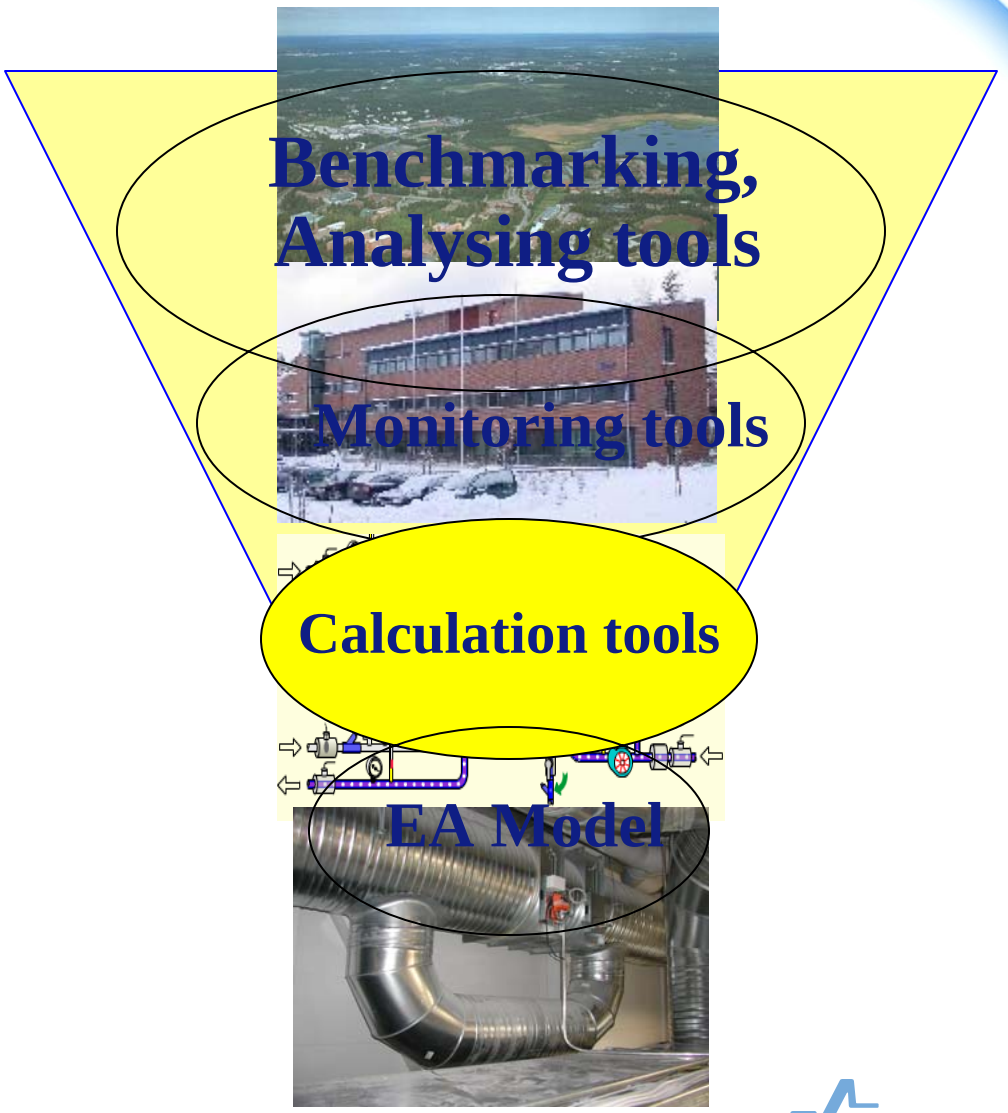
Examples of EA Tools:

1. Building stock

2. Building

3. System

4. Component



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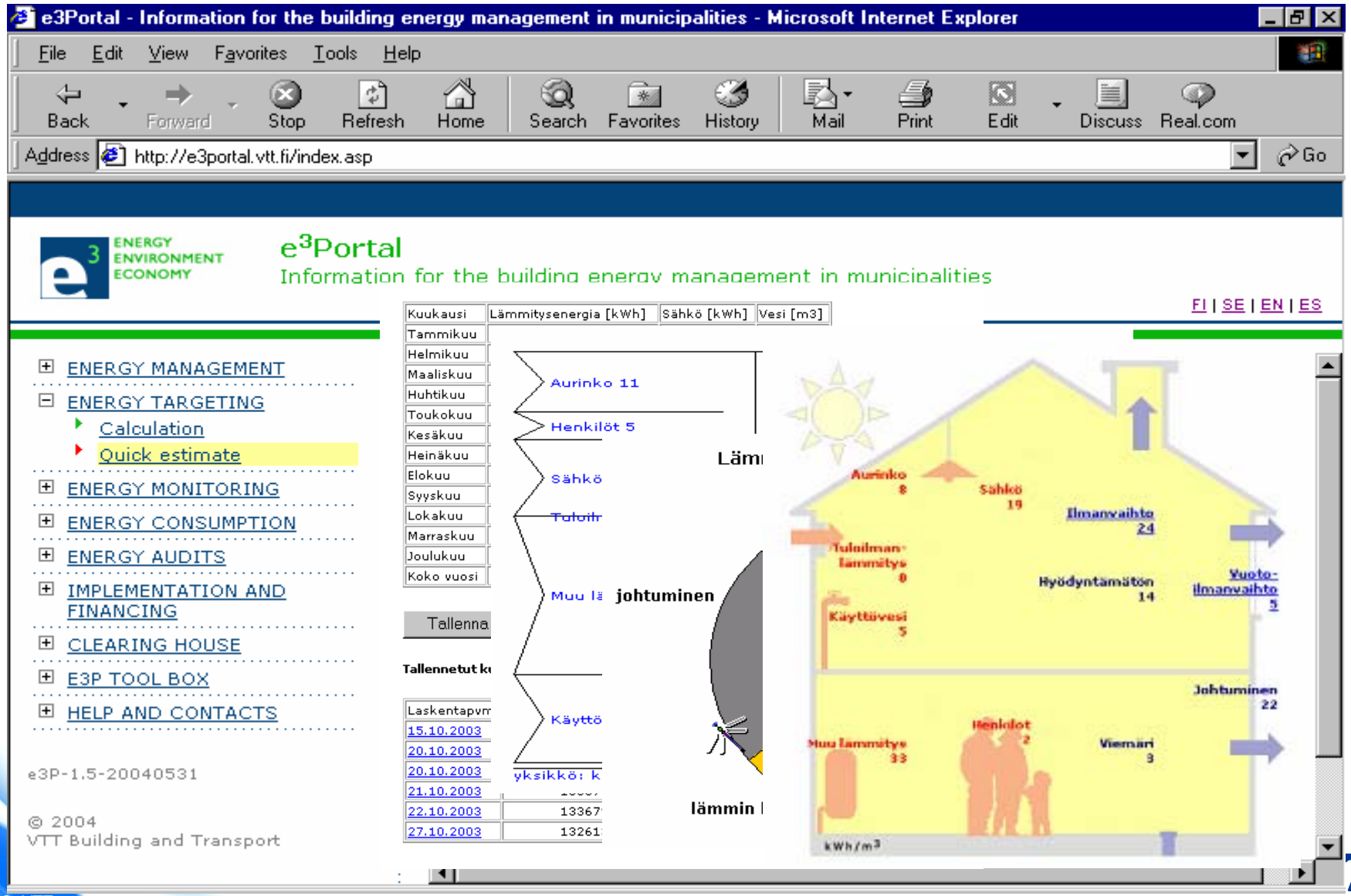
Calculation tools: (by Jari Shemeikka&Sami Karjalainen, VTT)



MOTIWATTI 2.0: ENERGY AUDITOR'S TOOL

(by Jari Shemeikka, VTT)

- Motiwatti is used in energy audits in Finland
- Properties:
  - Calculates the heating energy demand (space, ventilation and hot water), no cooling energy calculations
  - The electricity of fans in ventilation units is handled in detail
  - Easy to use principle
    - Fast shoe-box modeling of the building envelope with the help of the construction database defaults (categorized by building type and age)
    - Easy to use methodology for the energy saving measures

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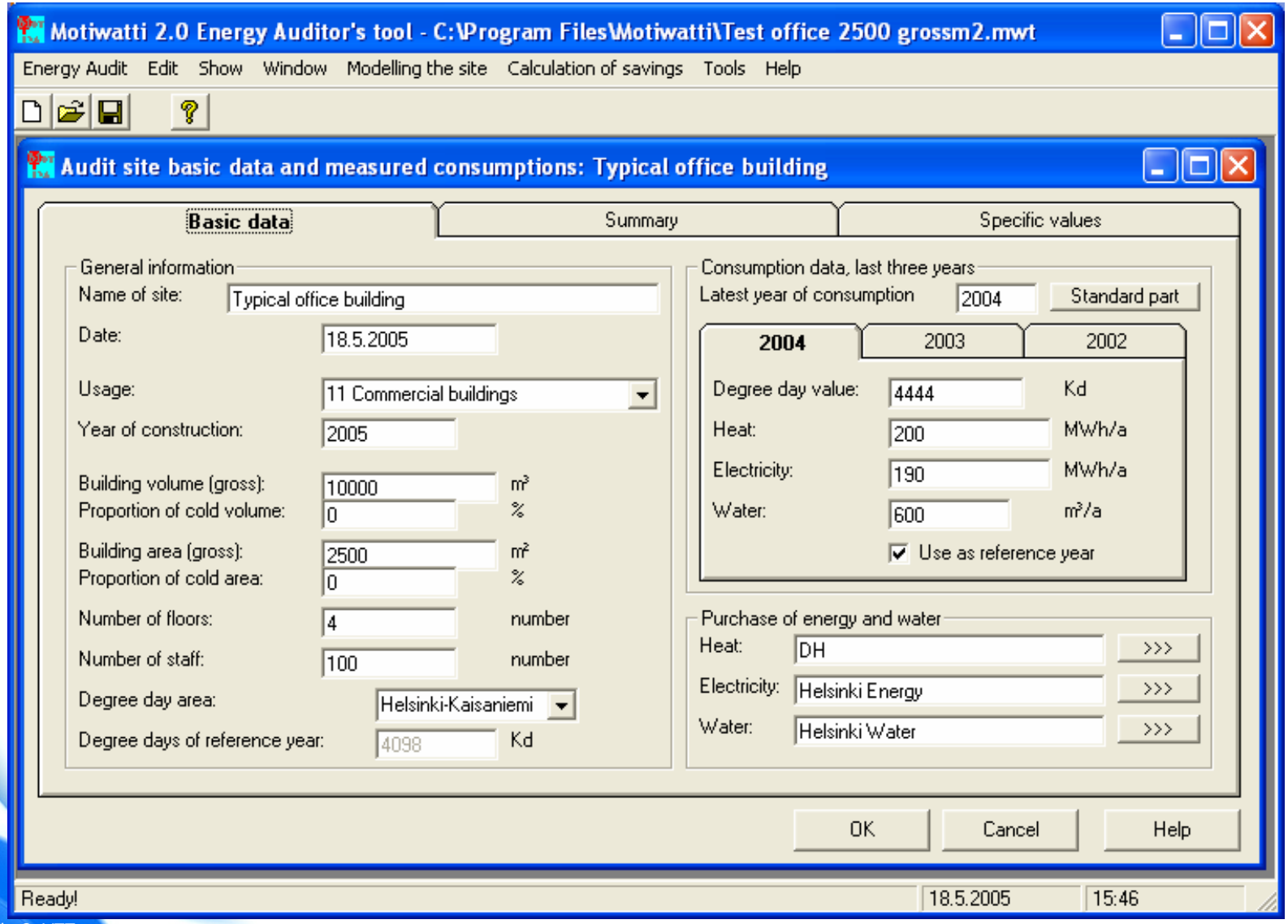
The basic data of the building



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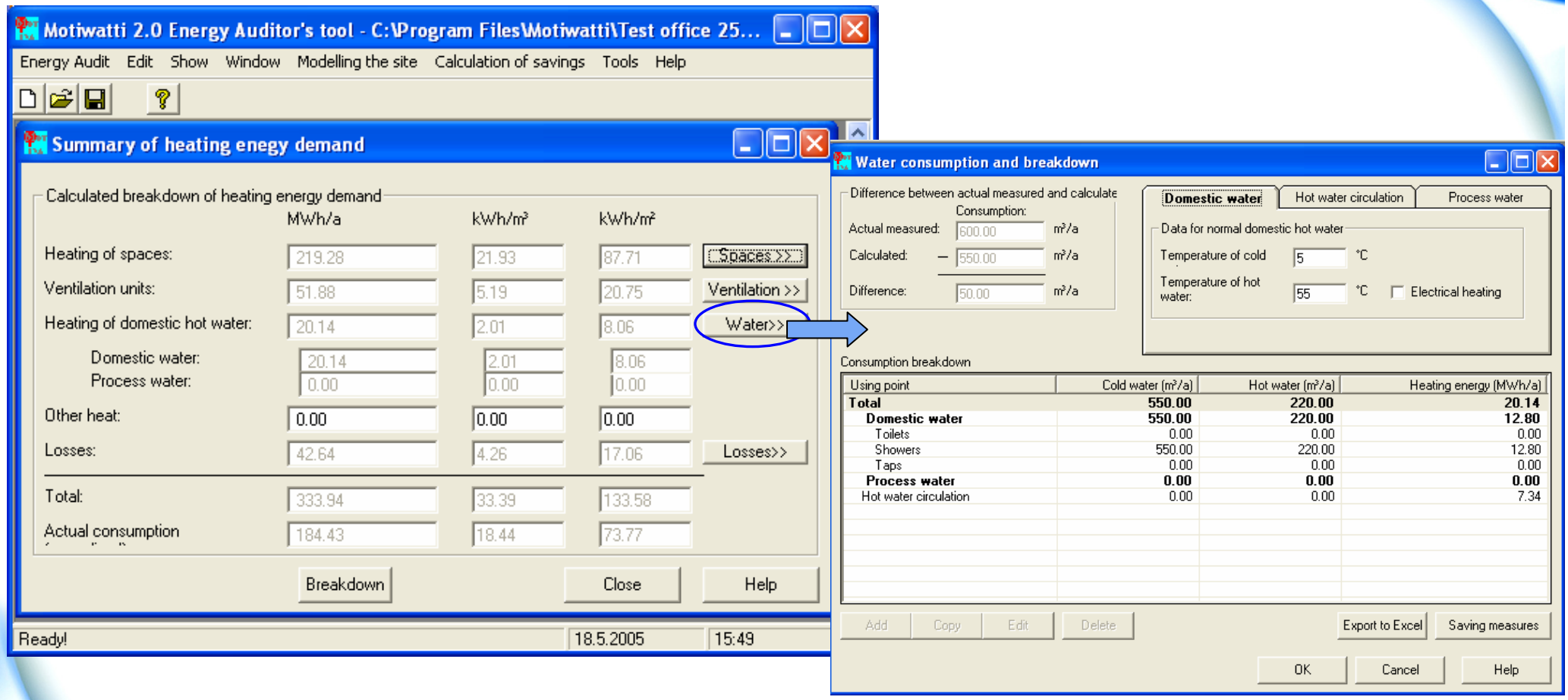
A sample of the HVAC-auditors' view



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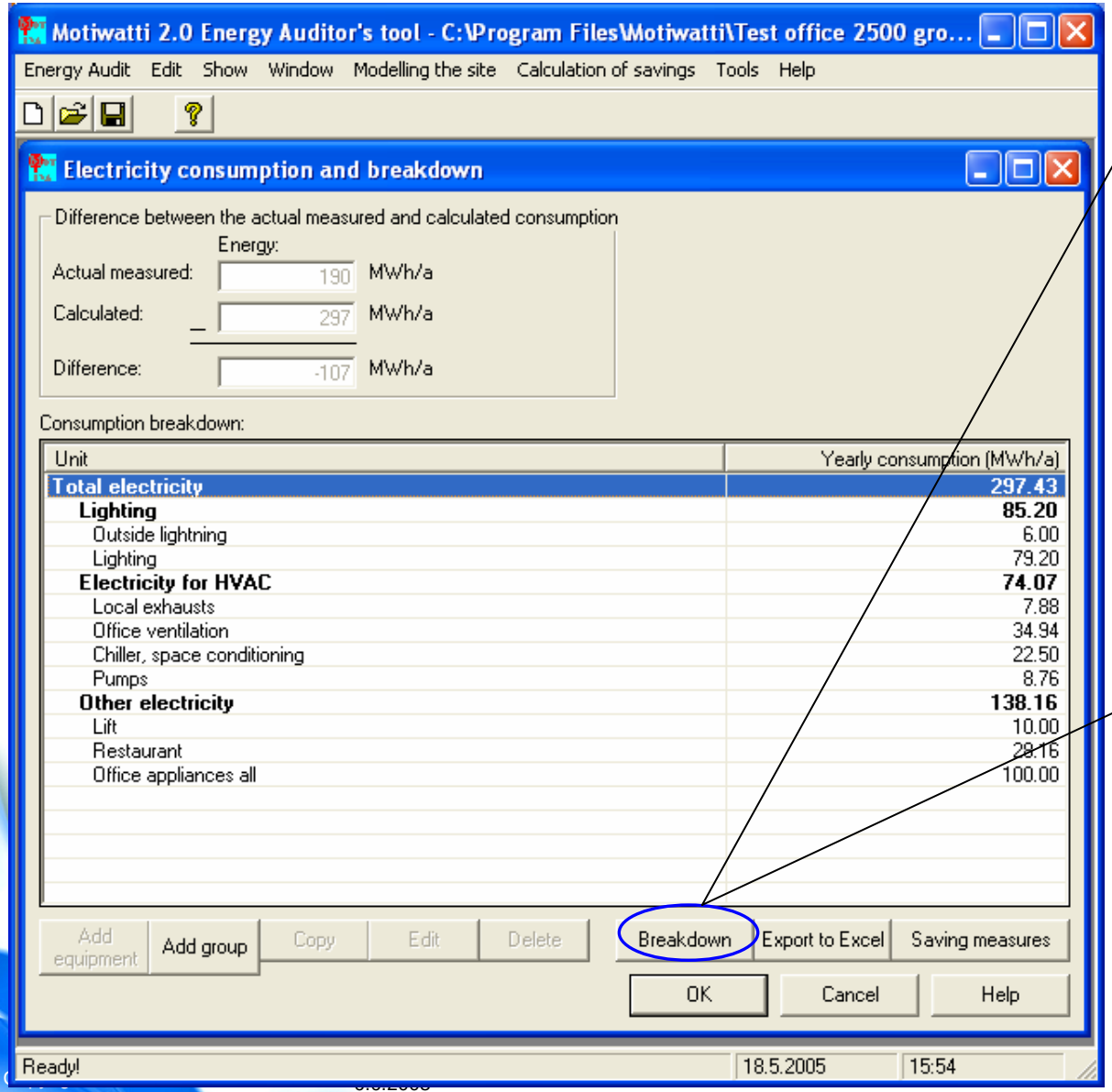
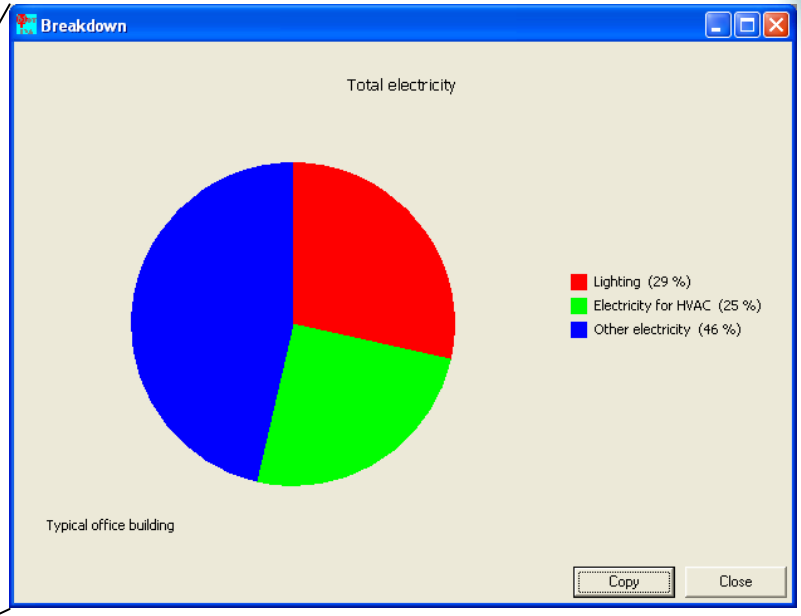
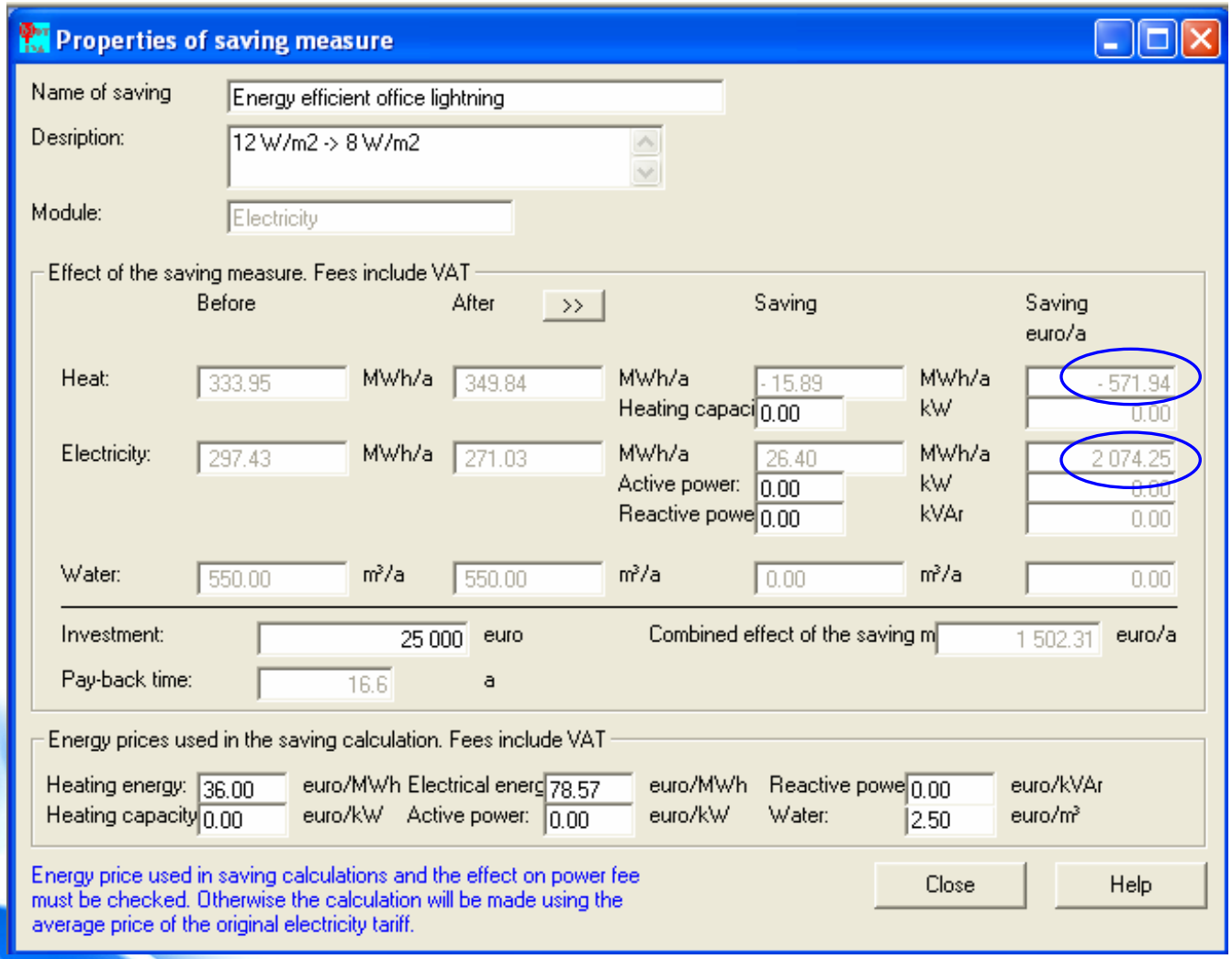
Summary of the electricity consumption





A sample view of one saving measure, energy efficient lightning



Motiwatti calculates the net saving

-saving lightning energy means increased space heating energy consumption

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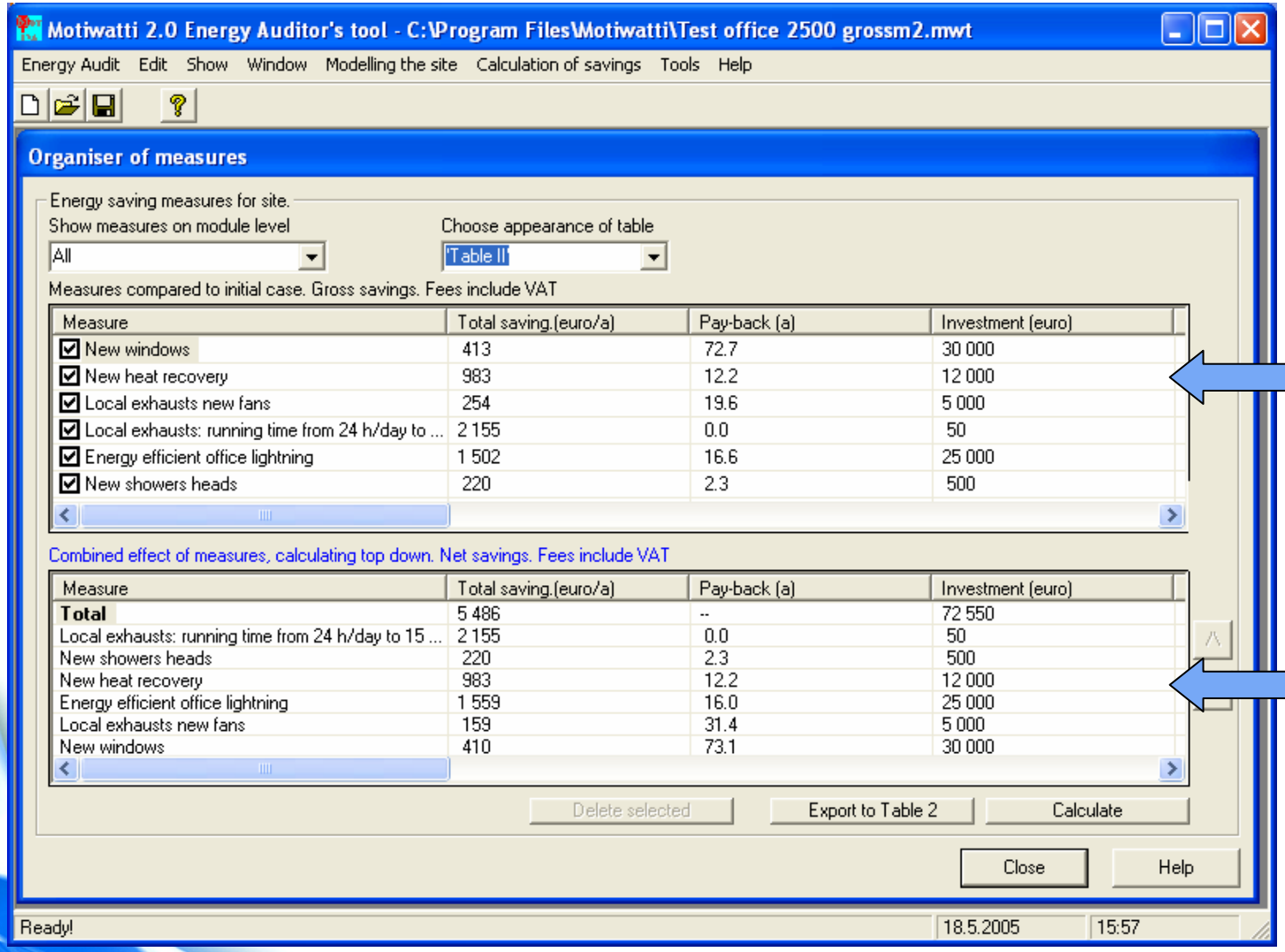
The summary of the energy saving measures



List of all individual calculated measures

List of the recommended measures calculated top down in chain

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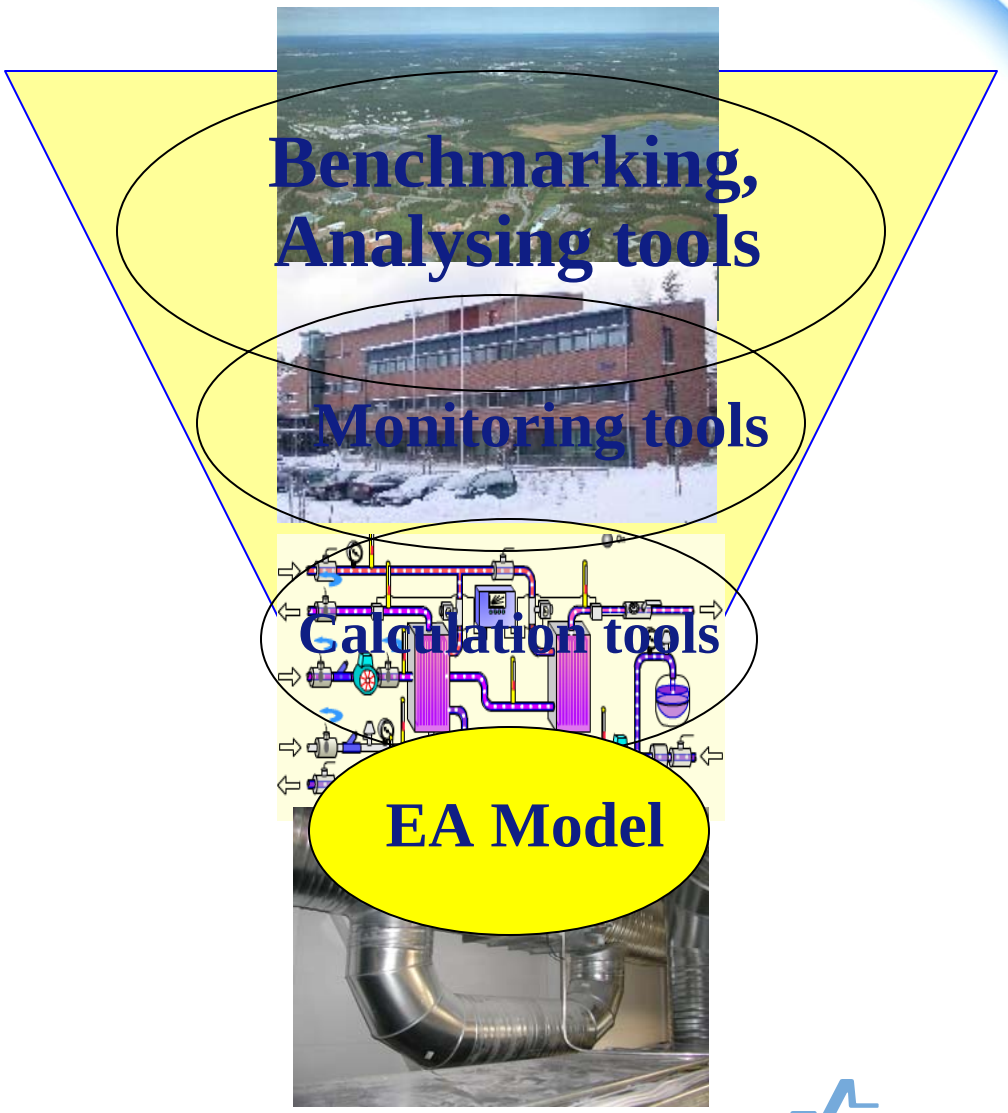
Examples of EA Tools:

1. Building stock

2. Building

3. System

4. Component



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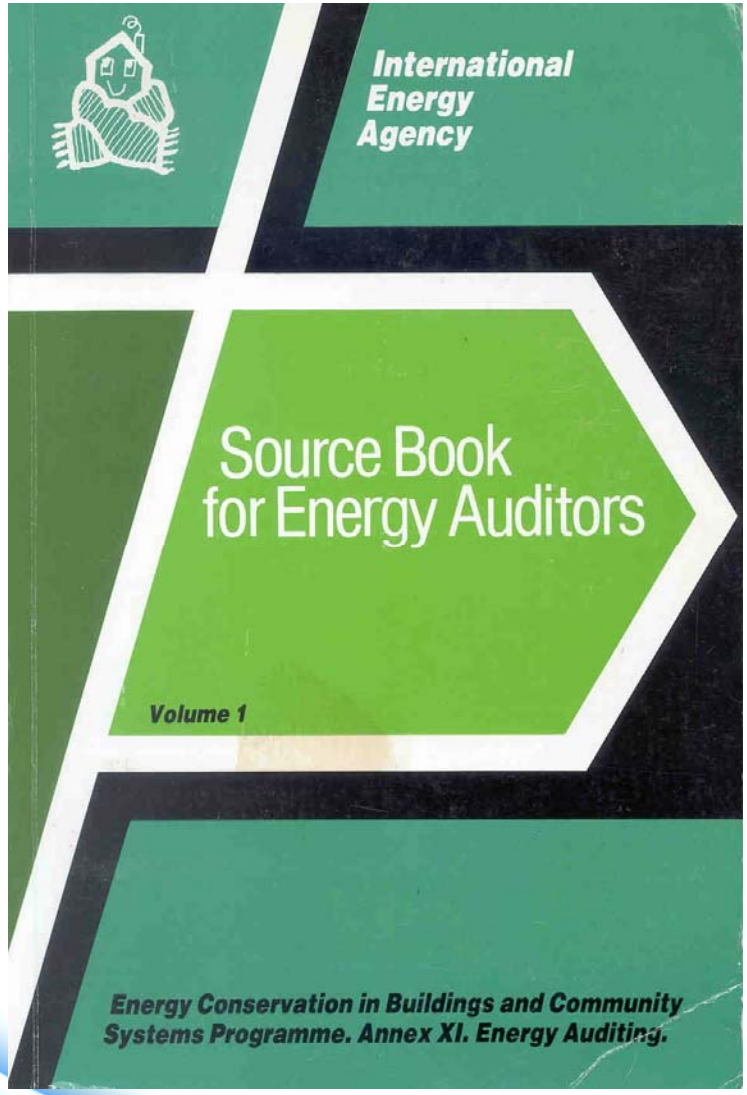

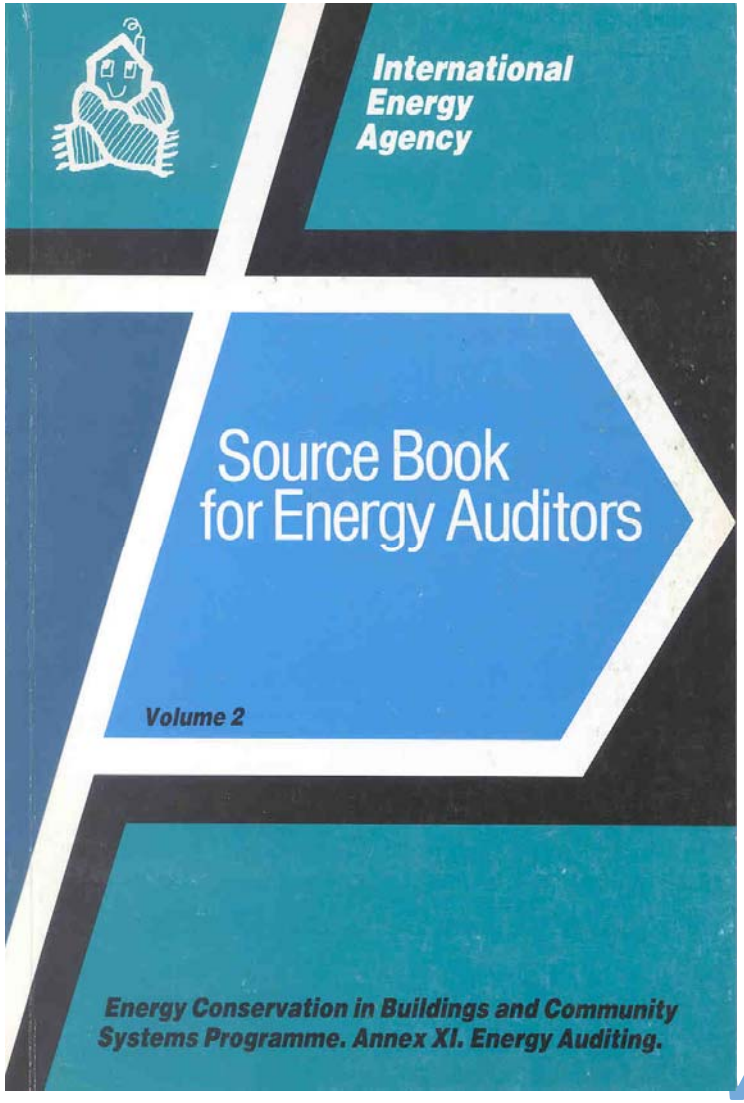

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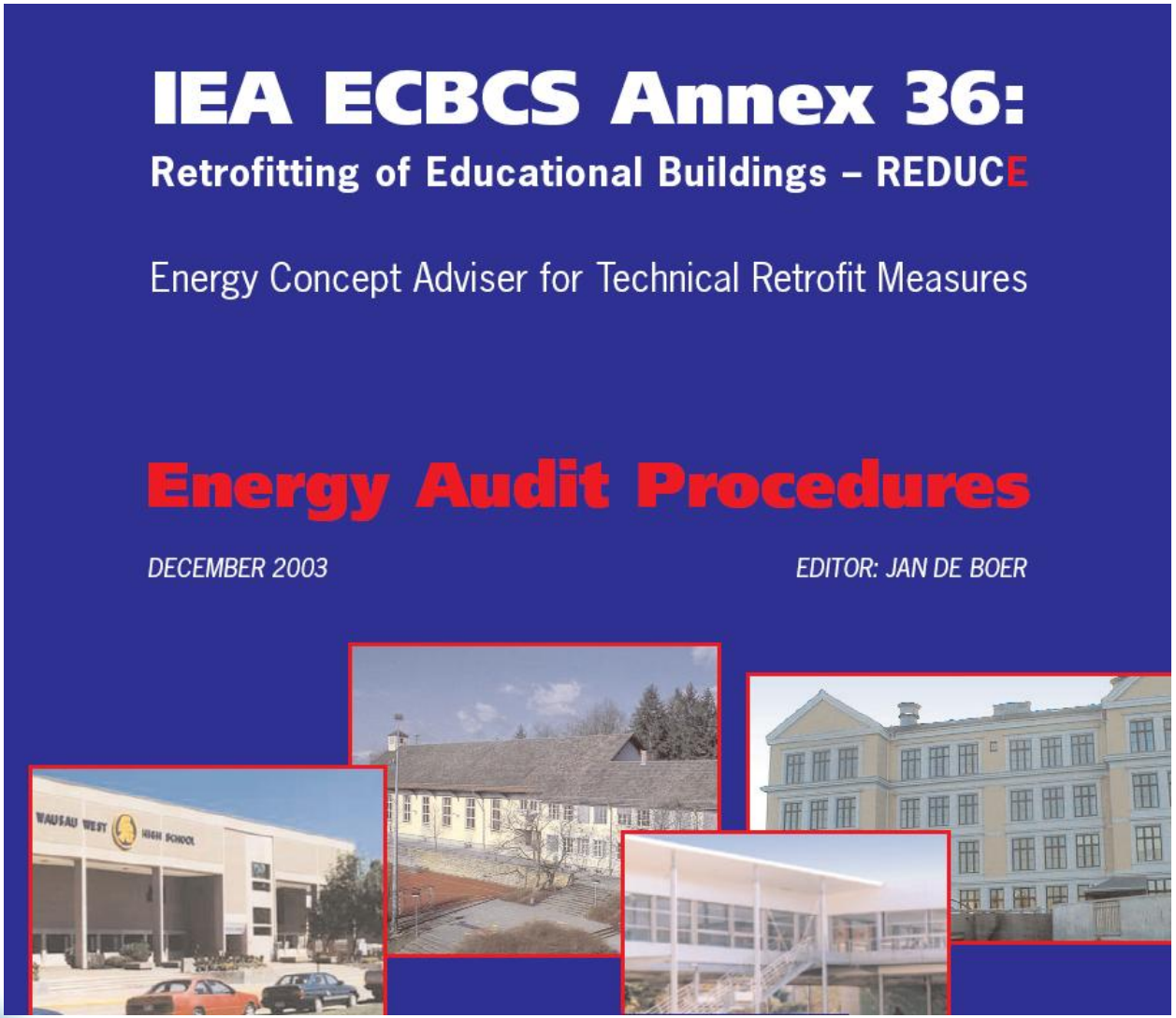

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What is an Energy Audit?

(Source:Motiva)

- **With energy audits we mean a systematic procedure in existing buildings/ sites/objects where the purpose is to**
  - evaluate the existing energy consumption
  - identify the energy saving potential and find the potential of renewable energy sources
  - report and make detailed saving proposals
  - (monitor the realisation of proposals/retrofit measures)
  - (assess the influences and and saving achieved)

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Motiva

Energiankäytön uusi suunta

National Information Center for Energy Efficiency

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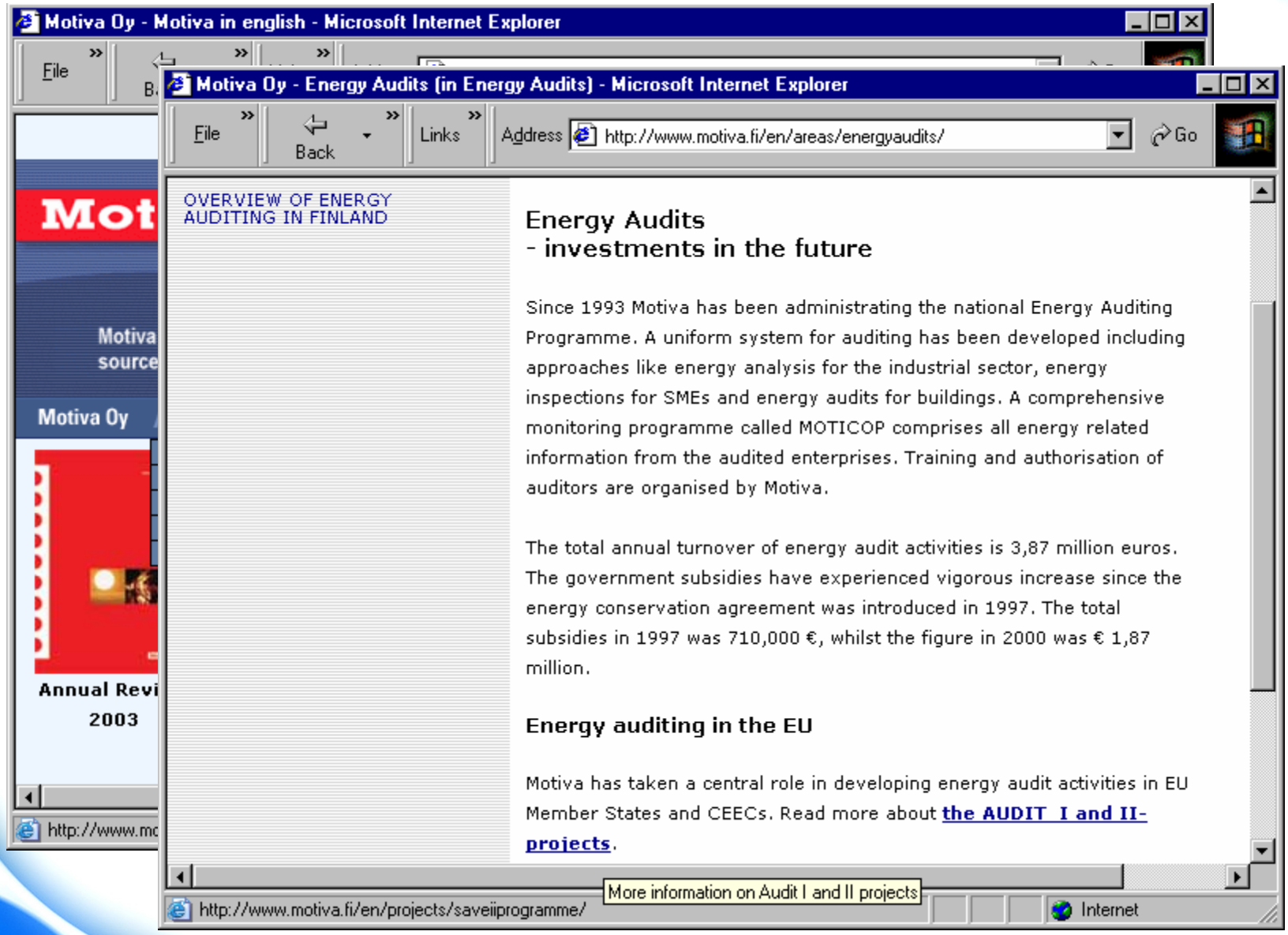

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Motiva

Haku Palaute Energialinkit

Pääsivulle Motiva Oy Toiminta-alueet Yrityksille ja yhteisöille Kuluttajille Kirjasto Julkaisut Uutiskeskus Ekstranet-palvelut

<< ENGLISH

ENERGY AUDITS

- Audit I project and Audit 1999 Conference
- Audit II Project
- Working Group Energy Audit, "Operating Agents' Network"

Audit I project and Audit 1999 Conference

Motiva co-ordinated the first European level study on energy auditing during years 1998-2000. This SAVE II Programme project "Energy Audit Management Procedures (AUDIT)" was implemented in co-operation with IFE (Norway) and C.R.E.S (Greece), also involved in energy auditing at national level. The Final Report presents the first theories on energy auditing as well as national experiences on all Member States. Some 1000 copies of the Final Report have been downloaded from over 40 countries since the report was published in March 2000.

(AUDIT – Energy Audit Management Procedures, SAVE II Programme, final report, load_pdf)

energy AUDIT 1999

International Conference on energy audits, AUDIT '99
10.-12.10.1999 Turku, Finland

Parallel to the AUDIT project Motiva hosted the first international conference on energy audits, AUDIT´99, in October 1999 in Finland.

Internet

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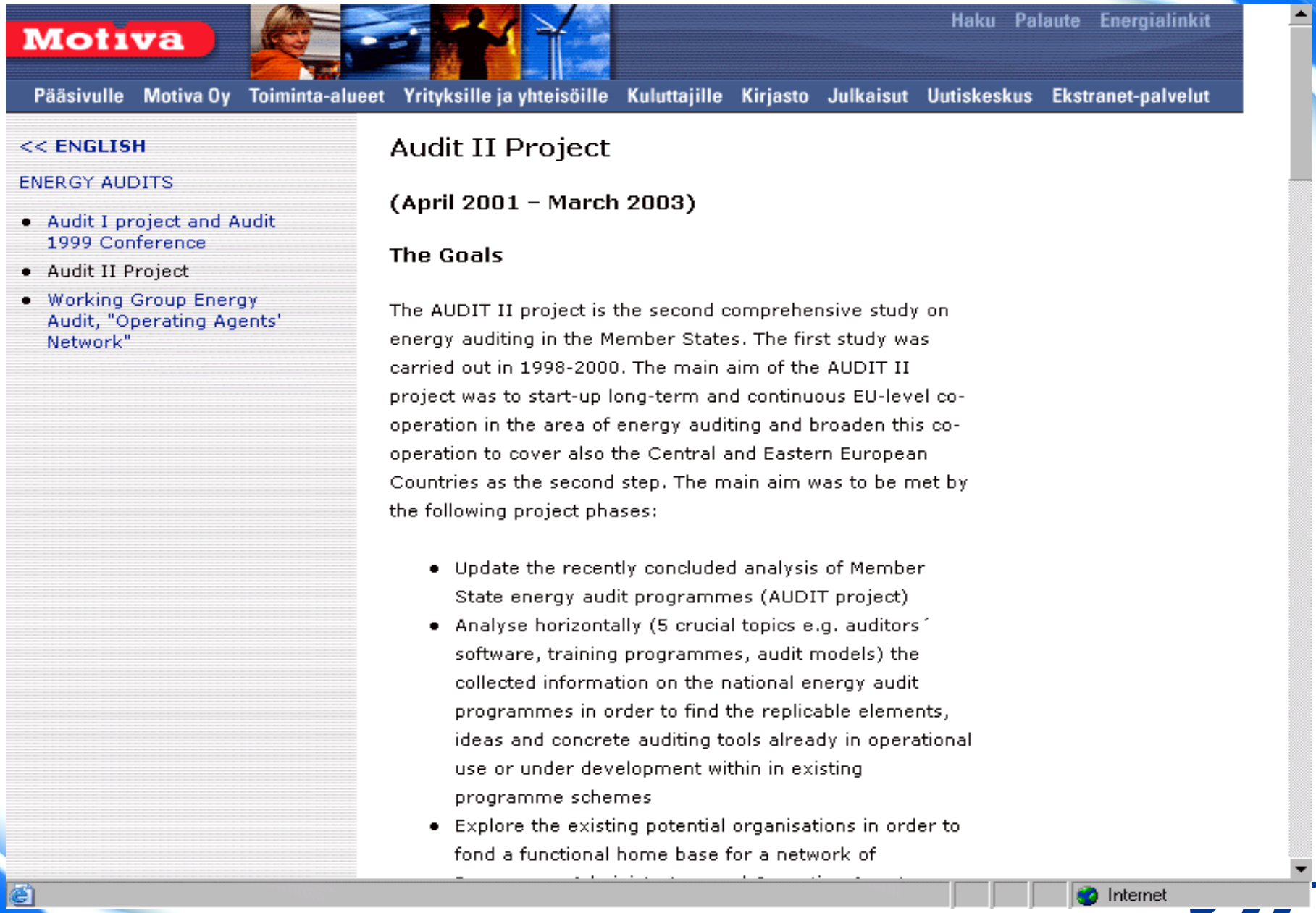

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The Guidebook for Energy Audit Programme Developers

Guidebook for Energy Audit Programme Developers
(**GB_Printversion.pdf**, size 834 kB)

The Topic Reports

TR Monitoring and Evaluation: Published September 2002
(AUDIT II Topic Report, **pdf**, 221 kB)
TR Energy Audit Models: Published April 2003
(AUDIT II Topic Report, **pdf**, size 309 kB)
TR Training, Authorisation and Quality Control:
UPDATED September 2002
(AUDIT II Topic Report, **pdf**, size 241 kB)
TR Auditor´s Tools: Published August 2002
(AUDIT II Topic Report, **pdf** , size 193 kB)
TR Implementing Instruments: Published September 2002
(AUDIT II Topic Report, **pdf**, 230 kB)

The Country Reports, Group I

CR Austria: Published August 2002
(AUDIT II Country Report - Austria, **pdf**, 264 kB)
CR Belgium: Published September 2002
(AUDIT II Country Report - Belgium, **pdf**, 247 kB)
CR Denmark: Published September 2002
(AUDIT II Country Report - Denmark, **pdf**, 245 kB)
CR Finland: Published May 2002
(AUDIT II Country Report – Finland, **pdf**, size 1,1 MB)
CR France: Published May 2002

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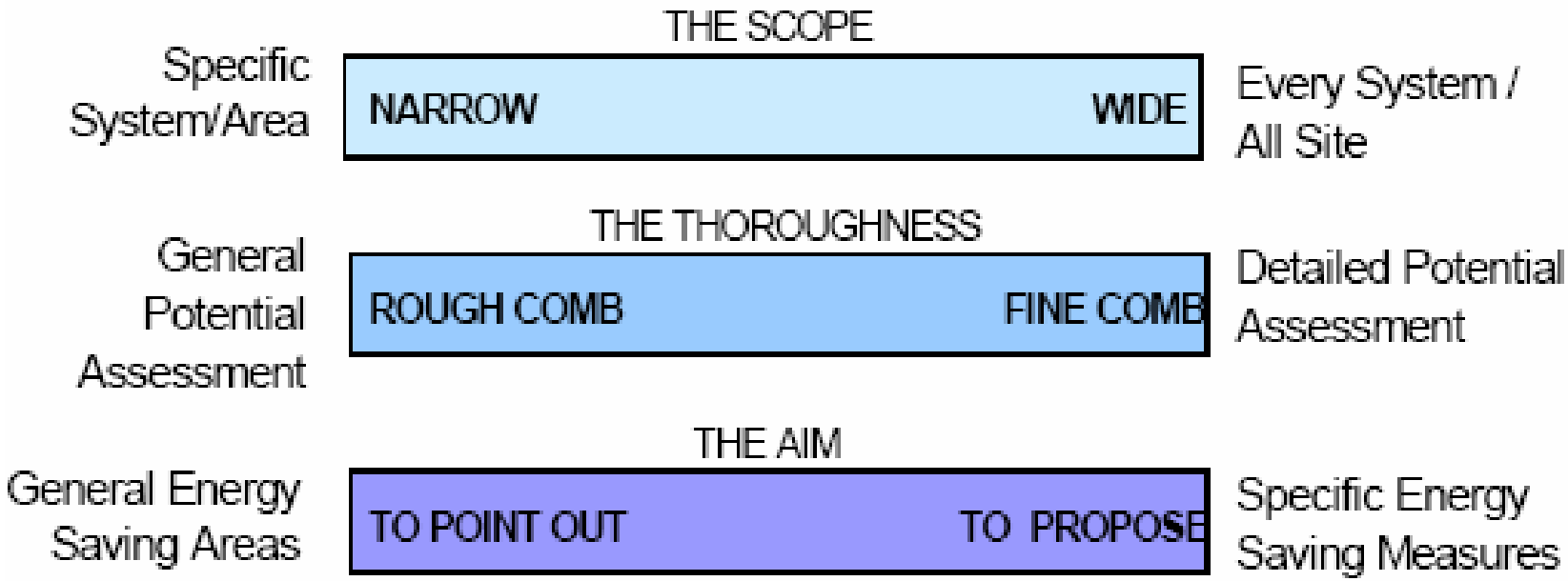
The properties of energy audit models



Source:SAVE-project AUDIT II

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The Core Audit is the heart of all possible energy audits and includes the steps of

- **evaluating** the present energy consumption
- **identifying** of energy saving possibilities
- **reporting**.

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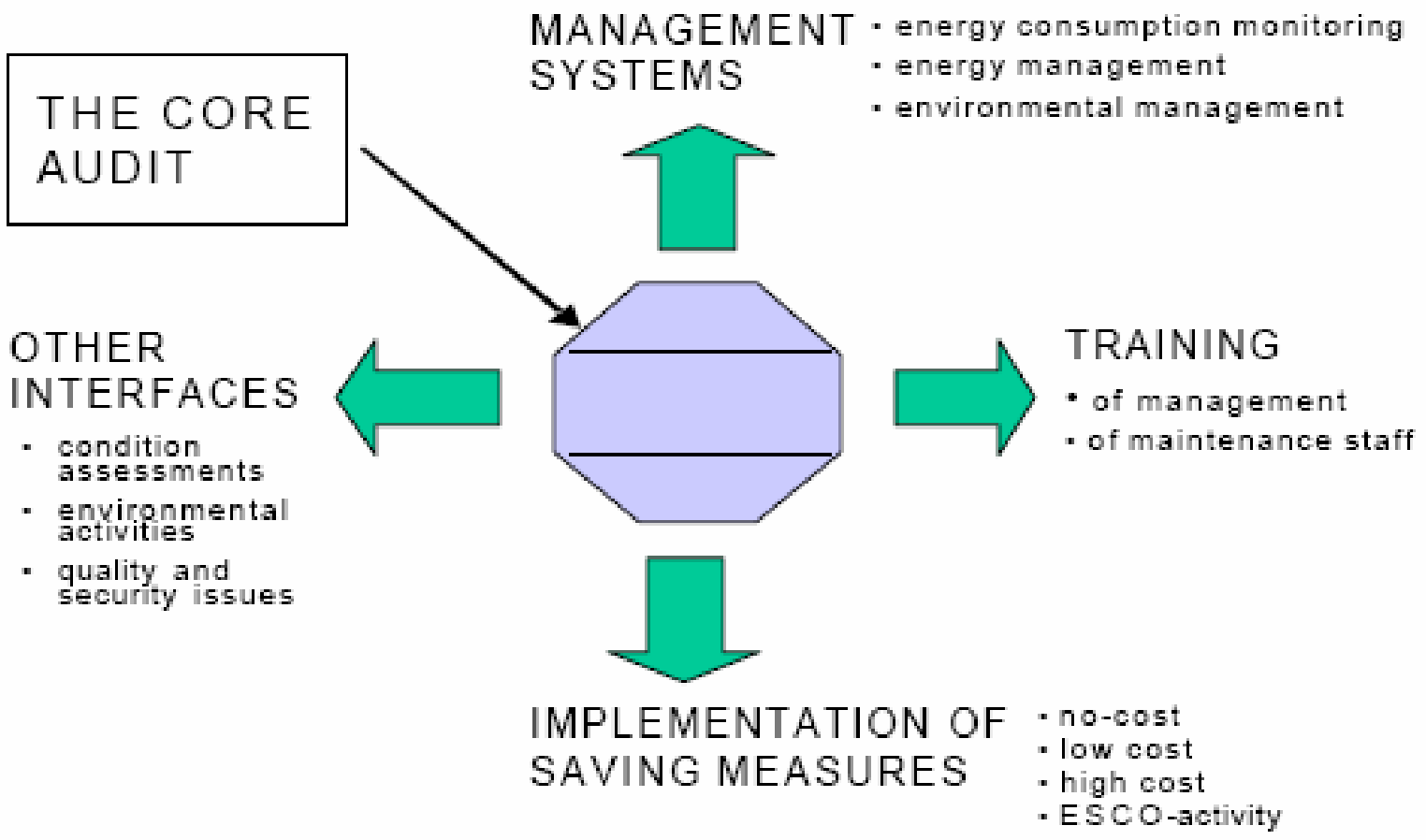

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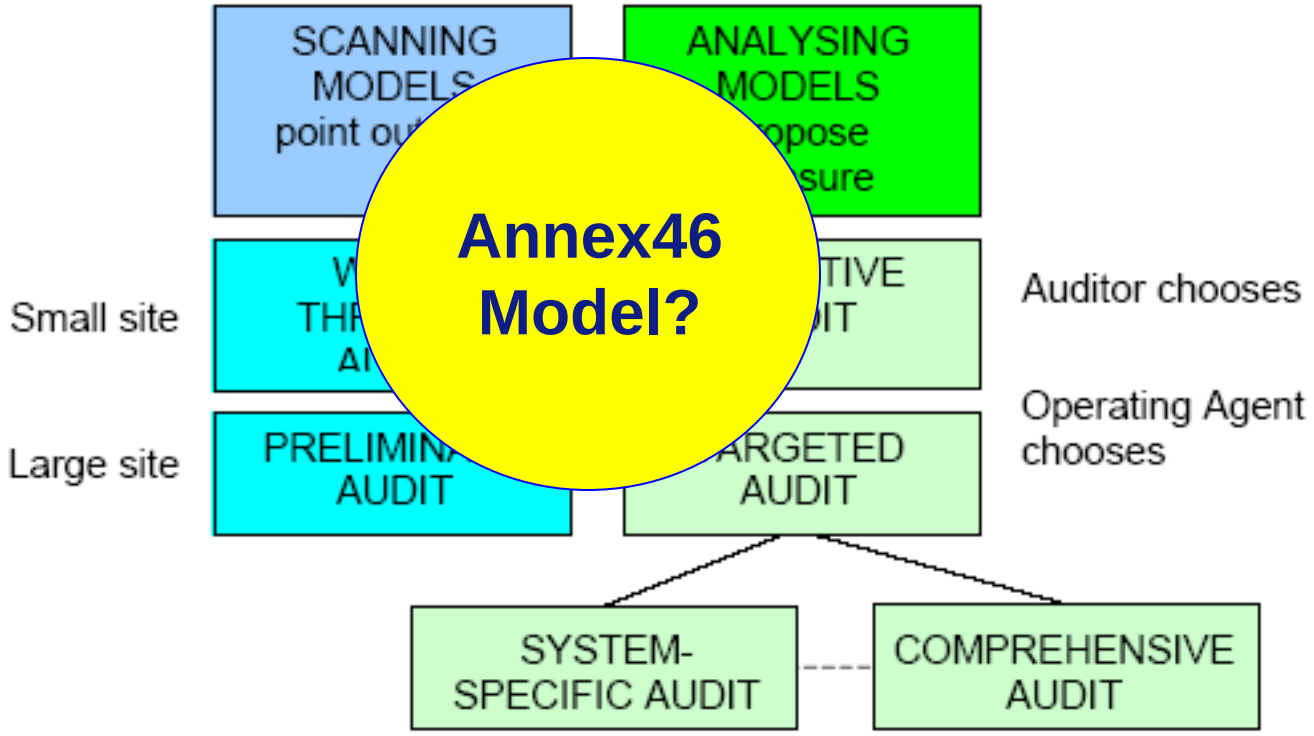
Basic Energy Audit Models

(Source:SAVE-project AUDIT II)



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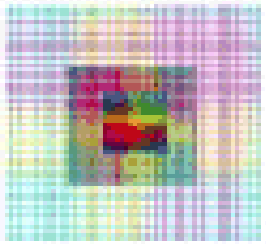

AUDIT II

Country Report
GERMANY

(Draft Version)

Michael Sattler

Final Report 13.12.2002

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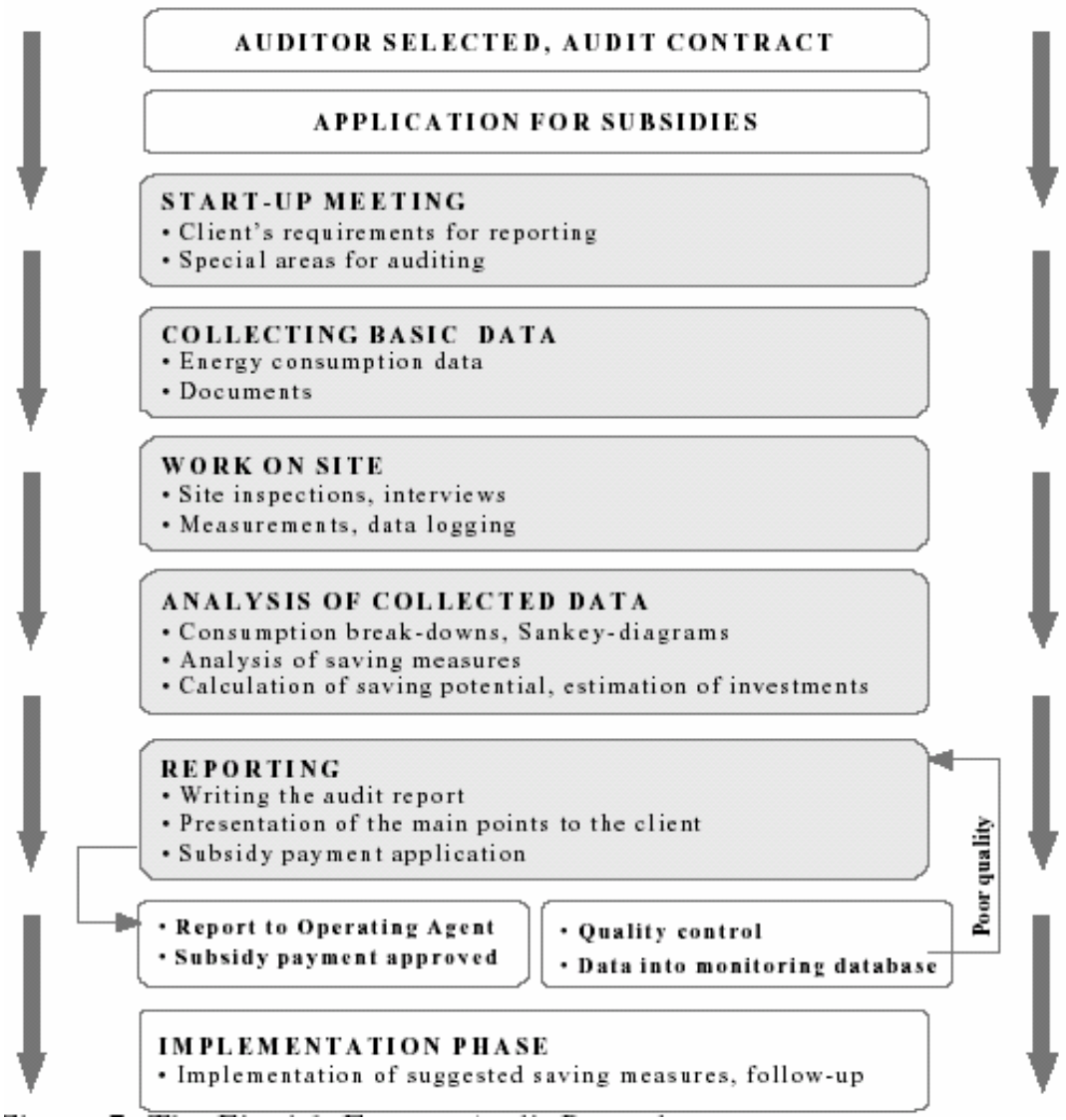
The Finnish Energy Audit Procedure

(Source:SAVE-project AUDIT II)



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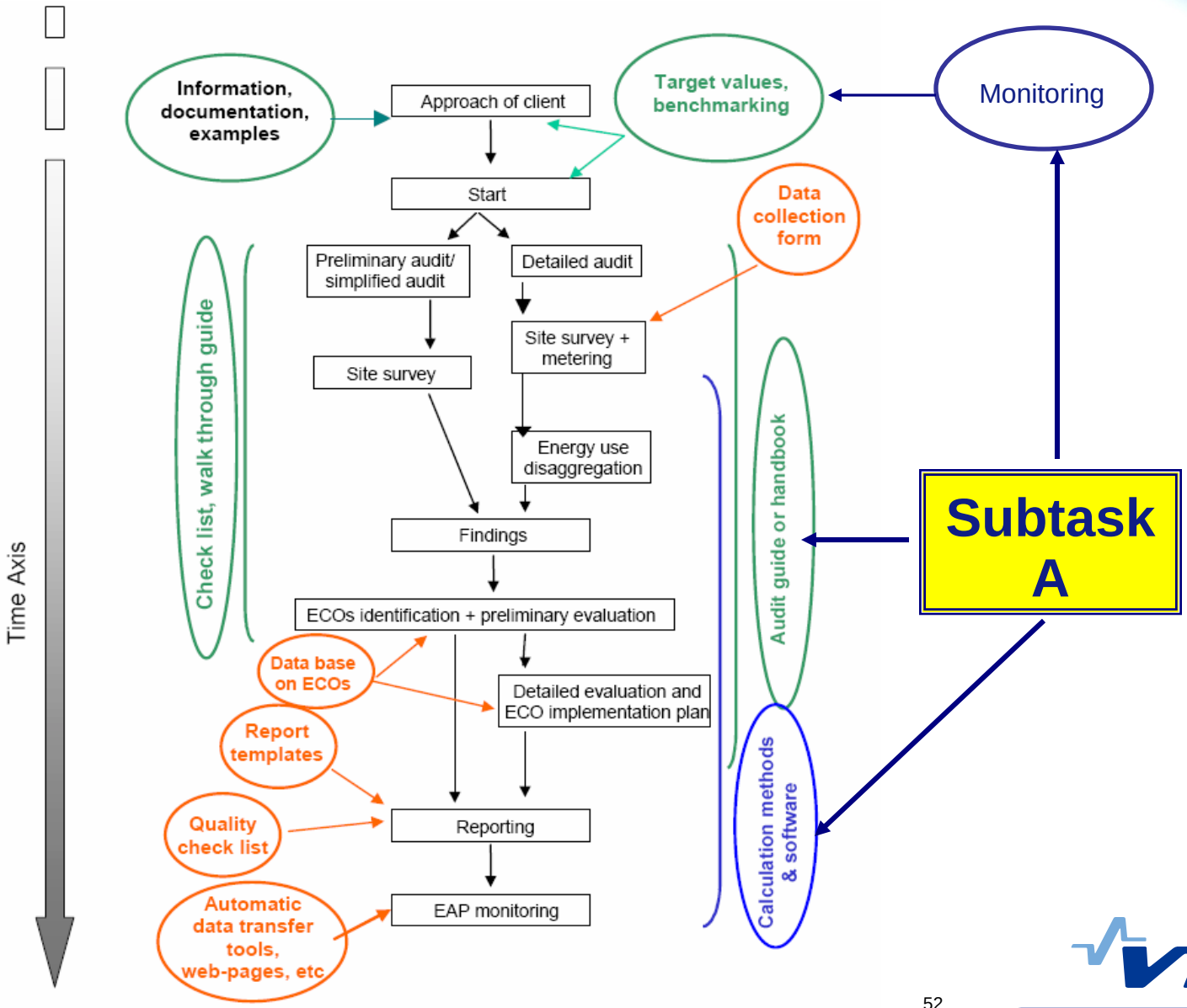
EA Tools (Source:SAVE-project AUDIT II)



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EA Tools

(Source:SAVE-project AUDIT II)

Definitions	Pros and Cons, comments
Information/documentation on technical topics (ECOs[3], Branch specific…)	
Information support document, it is often based on case studie and intended to help marketing the audits in view of successfu examples. Main target is the client of the audit.	Depending on the accuracy of the information these tools can also be considered and/or used as promotion support elements. These tools give clear message from the Administrator or the OA to the public
Audit guide or audit handbook, energy management handbook	
This tool explains and describes how an audit is to be made, how the calculations are to be conducted, the types and contents of the most frequently proposed energy conservation options (ECOs).	Core component of an energy audit scheme, the document is the basis of training sessions and is targeted essentially to auditors
Energy checks, Check-lists or walk through guides	
Associated to energy audit models of the scanning type, these supports are developed in order to facilitate the work of the auditor, assuring in the same time both quality and rapidity of the survey.	They can be used by energy managers for their own site or premises on a self auditing basis or more widely as a simple awareness raising instrument
Calculation methods and software	
Other core component of energy audit schemes, calculation methods and software are associated to energy audit models of the analysing type.	The use (by an auditor) of a recommended or certified (by the Operating Agent) calculation tool is an insurance of the quality on the results for the audit client. Developing software may become extremely expensive and time consuming for the Operating Agent.

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Data collection form(s)	
Generally associated to the calculation tool for which they constitute the input data, this type of support document helps the auditor in collecting all the necessary information for the survey.	It will be part of the final report and will also contribute to facilitating the follow up of the site energy features and the interpretation of the audit results and recommendations.
Report templates	
The report is the deliverable of the audit, proposing a template helps all the participants to make the most profit of the audit service, produce similar audit reports and good audit **quality.**	They are over all depending on the energy audit models and, in many programmes are integrated in the audit model specifications. As for data collection forms, they are frequently associated with the calculation tool of which the output results must be integrated in the report.
Check list for quality control of audit reports	
What is specified in the energy audit model, as expected results should be in the report: the checklist is an easy way to verify that the work has been done accordingly to the specifications.	Document to be used both at Operating Agent level and at auditor level (self-check), it is a complement or an alternative to report templates and a practical translation of Energy Audit Models
Building ratings, target values or benchmarking	
Key figures that can be used either as marketing information to spark off the need for energy audits.	They are also used by the auditors as technical data to justify their recommendations in the case of simplified audits, and even can contribute to detailed audits in checking calculations or replacing data difficult to meter or evaluate either way.
Data bases on energy conservation Options (ECOs)	
Detailed information on costs and implementation side aspects or consequences of energy saving recommendations. A database of ECOs will save a lot of time and money to the auditor (and thus help lower the cost of the audits with a maintained quality).	Keeping the data up to date requires quite a lot of work from the OA.

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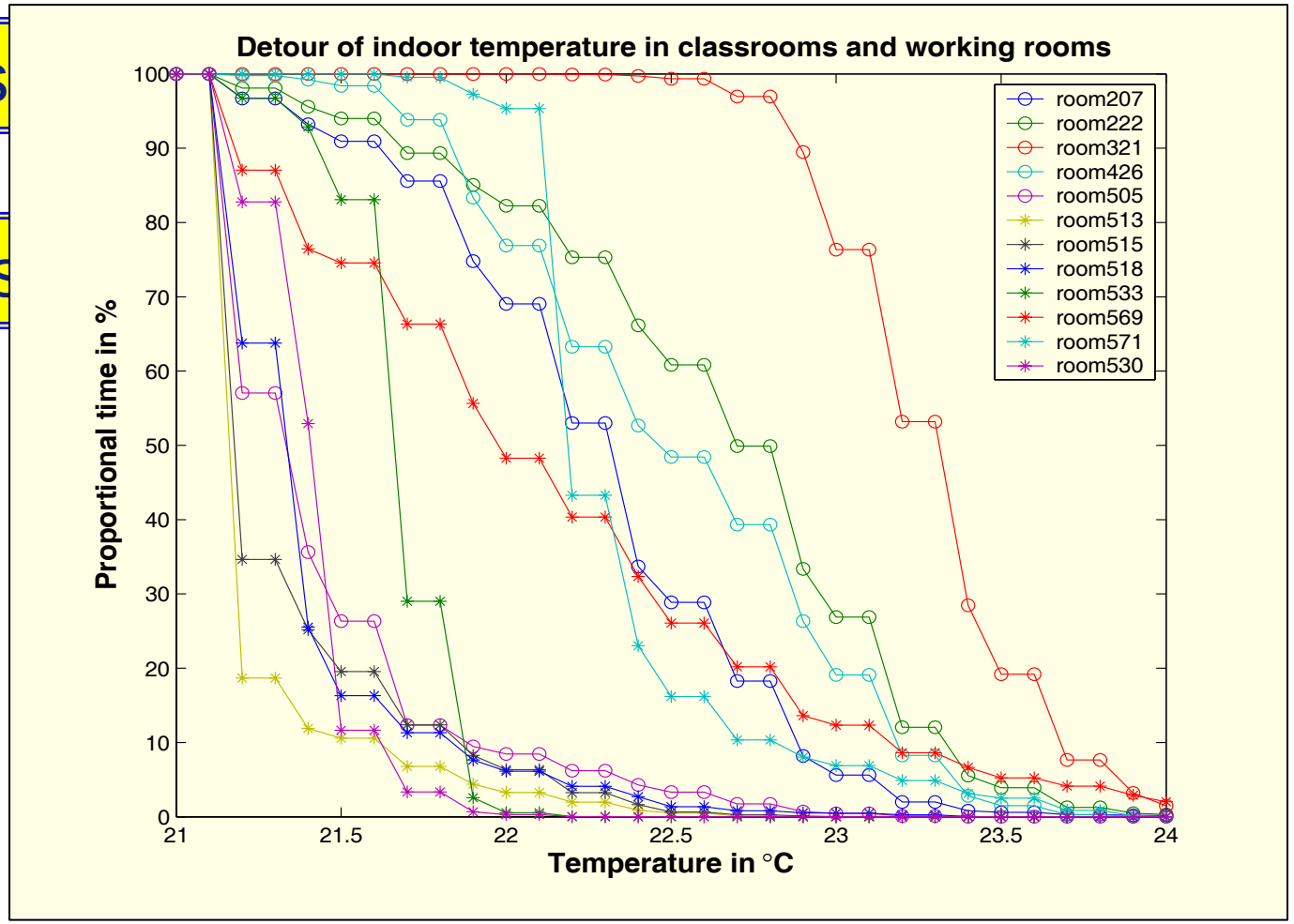

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Building Stock (Portfolio)

- Owner´s Scope = Management
- Need for processed (filtered) Information
  - Energy
  - Economy
  - Environment
- Monitoring&Targeting (Yearly&Monthly Energy Data)
- Benchmarking (wasters, big consumers)
- Basis for Decision Making

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Building

- User´s Scope = IAQ, Thermal Comfort
- M&O personnel, activities essential
- Monitoring&Targeting (Monthly&Daily Energy Data)
- BEMS, M&O Manuals

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Building Systems

- Envelope, HVAC, Lighting,etc. (look e.g. ASHRAE Guideline, The Commissioning Process)
- Monitoring&Process Control (Daily&Hourly Data)
- Energy
  - Economy
  - Environment
- Basis for Decision Making

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Components, equipments

- Vendor´s Scope = Management
- Specifications,
- Testing, balancing (TAB)
- Manuals etc. information

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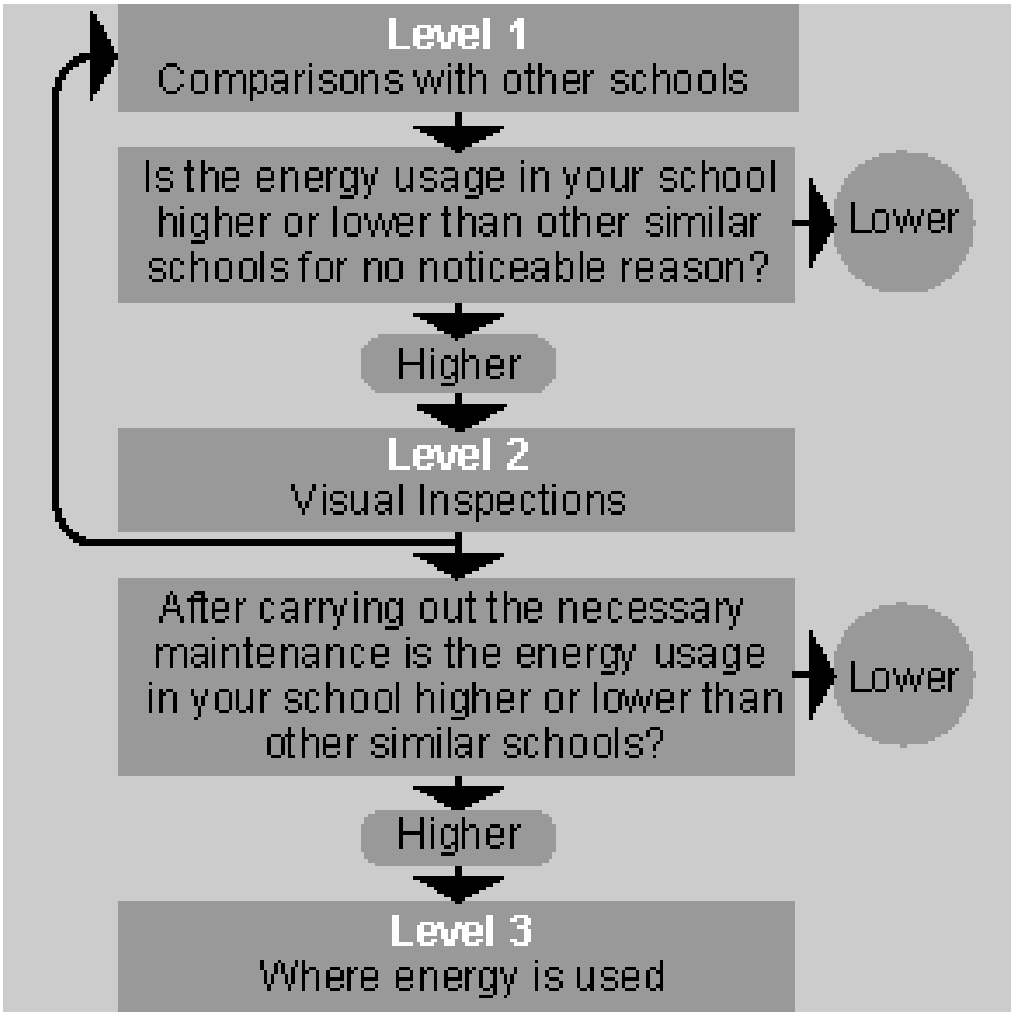

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What is Motiva?

- Established in 1993
- Motiva Oy is an impartial and state-owned company with 23 employees and annual turnover of 4 million €
- Motiva is a service organisation promoting a market for renewable energy sources and efficient energy use
- Motiva produces, refines and disseminates information, develops methods and boosts the introduction of advanced technology.
- Motiva implements the government's decisions on energy conservation and promotion of renewable energy sources.

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Subsidy policy

- Energy Auditing is voluntary
- Following the Audit Guidelines given by Motiva and MTI entitles the client to apply for audit subsidies
- The subsidy is specified yearly
- In 2002 the subsidy is 40 % of the approved auditing costs
- Subsidies for energy saving investments are available for companies etc. in Voluntary Agreements

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Motiva's tasks in EA-Programme

- **Overall co-ordination of the Audit Programme**
- **Promotion of energy auditing**
  - promotion material, website, presentations
- **Preparation of audit Guidelines with MTI**
- **Development of the Audit Programme**
- **Training and authorisation of auditors**
- **Quality control on auditors' work**
- **Monitoring of volumes and results**
- **Advice to auditors and clients**

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A Walk-Through Energy Audit is a scanning model typically used in tertiary buildings where the energy consuming systems are quite simple and the probable areas for potential energy saving measures are known in advance.

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A Preliminary Energy Audit is the scanning energy audit model for large sites in the process industry. Most of the work in the Preliminary Energy Audit is in building up a reliable breakdown of the present total energy consumption and in defining the areas of the significant energy consumption.

The audit points the most obvious savings and also points out the areas where supplementary “second-phase audits are needed and how they should be targeted

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For the ***Selective Energy Audit*** the Operating Agent gives only general guidelines and therefore the auditor is allowed to choose the level of approach, both in coverage and accuracy. This audit model is very cost-effective, when used by neutral, target-oriented and experienced auditors but may also, in the worst case, concentrate on only the obvious savings and ignore everything else.

From the Operating Agent`s point of view this model is problematic because the quality control on this kind of audits is very difficult.

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For the ***Targeted Energy Audit*** the Operating Agent defines clear specifications on the content of the audit. The audit may concentrate on one specific energy using system (boiler, compressed air system) or cover all energy use of the site.

There are various possibilities to create the technical content of a targeted audit. This model creates a basis for a standard and detailed reporting which brings some advantages to the Operating Agent especially in quality control and monitoring.

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The targeted audits range from a One-system Audit to a Comprehensive Audit that covers all energy use.

The ***Comprehensive Energy Audit*** is one of the most typical applications of the Targeted audits. The Comprehensive audit covers all energy usage of the site, including mechanical and electrical systems, process supply systems, all energy using processes, etc.

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Auditor´s Tools

The wording "**tools for audits**" or "**auditors' tools**" describes a large family of support documents and applications which are intended to facilitate the work of auditors in the view of both minimising audit costs AND maximising audit quality.

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INDUSTRIAL ENERGY AUDIT RESOURCES

- Oregon Office of Energy - Industry Energy Auditing
  http://www.energy.state.or.us/industry/analysis.htm
- Northwest Energy Efficiency Alliance - Technology Development
  http://www.nwalliance.org/
- Energy Ideas Clearinghouse - Efficiency Information Resource
  http://www.energyideas.org/
- U.S. Industrial Assessment Centers - Energy Audit Guides
  http://oipea-www.rutgers.edu/documents/doc_f.html
- U.S. Environmental Protection Agency - Auditing Tools
  http://yosemite1.epa.gov/estar/business.nsf/
- U.S Department of Energy - Best Practices Tools
  http://www.oit.doe.gov/industries.shtml

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Data from Existing Utility Meters

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Benchmarking is an effective way

Specific Consumption of Energy in some Schools of Helsinki

Heating **(kWh/m3)**

Code	School	1996	1997	1998	1999	Total cons. year 1999 'MWh)
HEL21187	Kontulan	81,1	83,1	89,4	82,2	.218
HEL21690	Pukinmäen	24,7	87,3	93,5	81,6	110
HEL21648	Pohjois-H	64,9	71,7	86,7	74,6	42
HEL21186	Pakilan y	44,7	62,3	66,4	61,8	.270
HEL21198	Vesalan y	52,6	53,8	54,3	57,5	.343
HEL21116	Kannelmäe	48,5	44,5	53,7	53,8	.105
						828
						.531
						454
HEL21143	Jakomäen	41,6	40,4	44,6	44,3	.211
HEL21055	Oulunkylä	45,3	45,3	54,8	43,9	828
HEL21185	Pakilan a	41,7	42,5	44,2	43,8	765
HEL21236	Käpylän y	35,5	38,0	39,3	38,5	.145
HEL21017	Vallilan	37,2	33,6	39,6	35,6	582
In average		47,2	49,1	57,4	50,6	

For Best Practice Dissemination!

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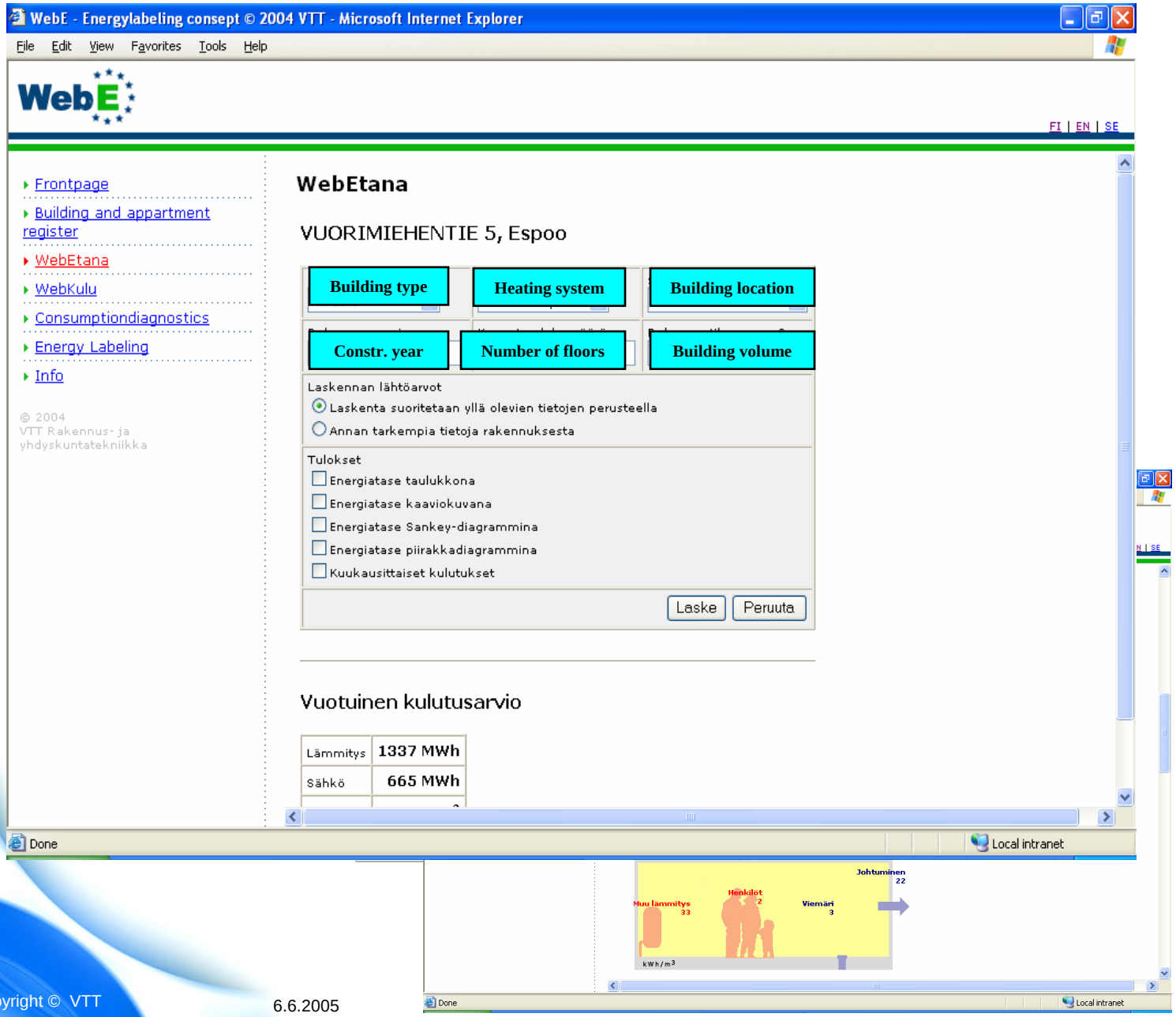

Energy consumption estimate calculation with WebEtana

- Energy calculation needs very few input parameters. More data for the calculation is generated from the system's default value database according to the year built, type of the building, type of the heating system, total room area, and geographical location.
- it is possible to adjust and define the calculation parameters if needed
- the results can be displayed in charts etc.
- the result can be exported to an energy consumption monitoring module
- Easy, simple, fast, and accurate enough

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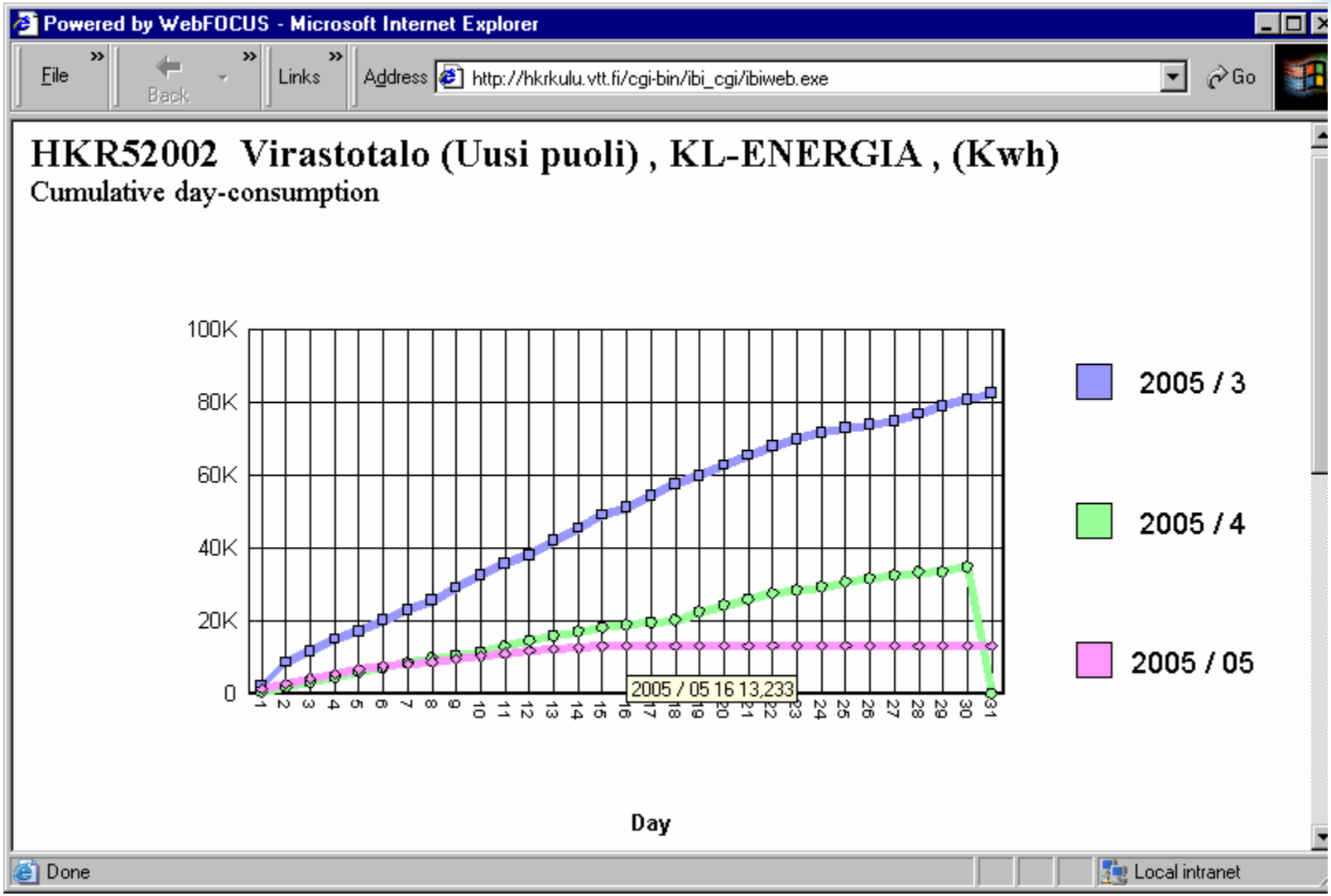

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Information Dissemination

Tähän esim. Motivan esimerkki-kortit ja ulkolaisia aineistoja (ks. EnergySavingInfo/UK)

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1. Monitoring& Targeting,

- data collection sw-tools
- AMR-over internet
- cons. statistics, analyses

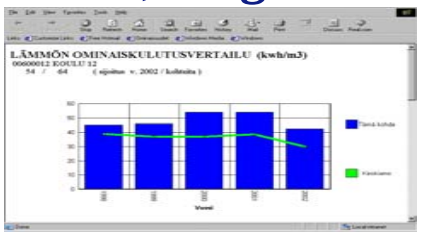
0. General Information

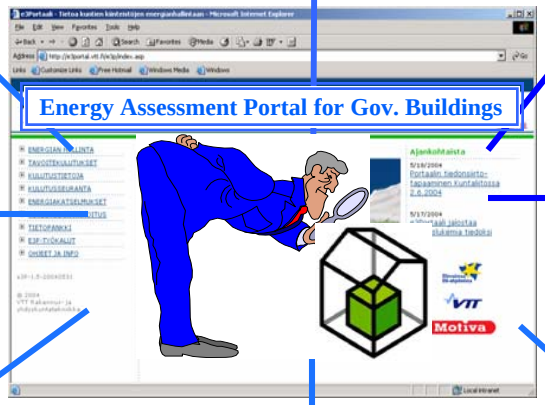
- Background
- Motivation
- Partners, Actors
- Links to other sites

7. Realisation, financing

- Risk management
- Escos, EPC´s etc.
- M&V (Commissioning)
- eBusiness-framework

2. Benchmarking, control, diagnostics



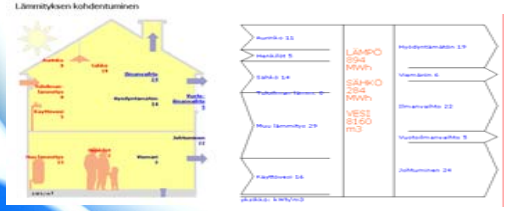


6. EnergyConceptAdviser

- saving technologies
- product information
- companies, services
- best practice info

3.Calculation tools

- WebEtana, RET etc.



4. Energy Auditing

- general guidelines
- best-case examples
- sw-tools (Motiwatti)
- paybacks etc.

5. Envelope&IAQ performance evaluation

- **Thermal scanning**
- **Air-tightness**
- **Other measurements**

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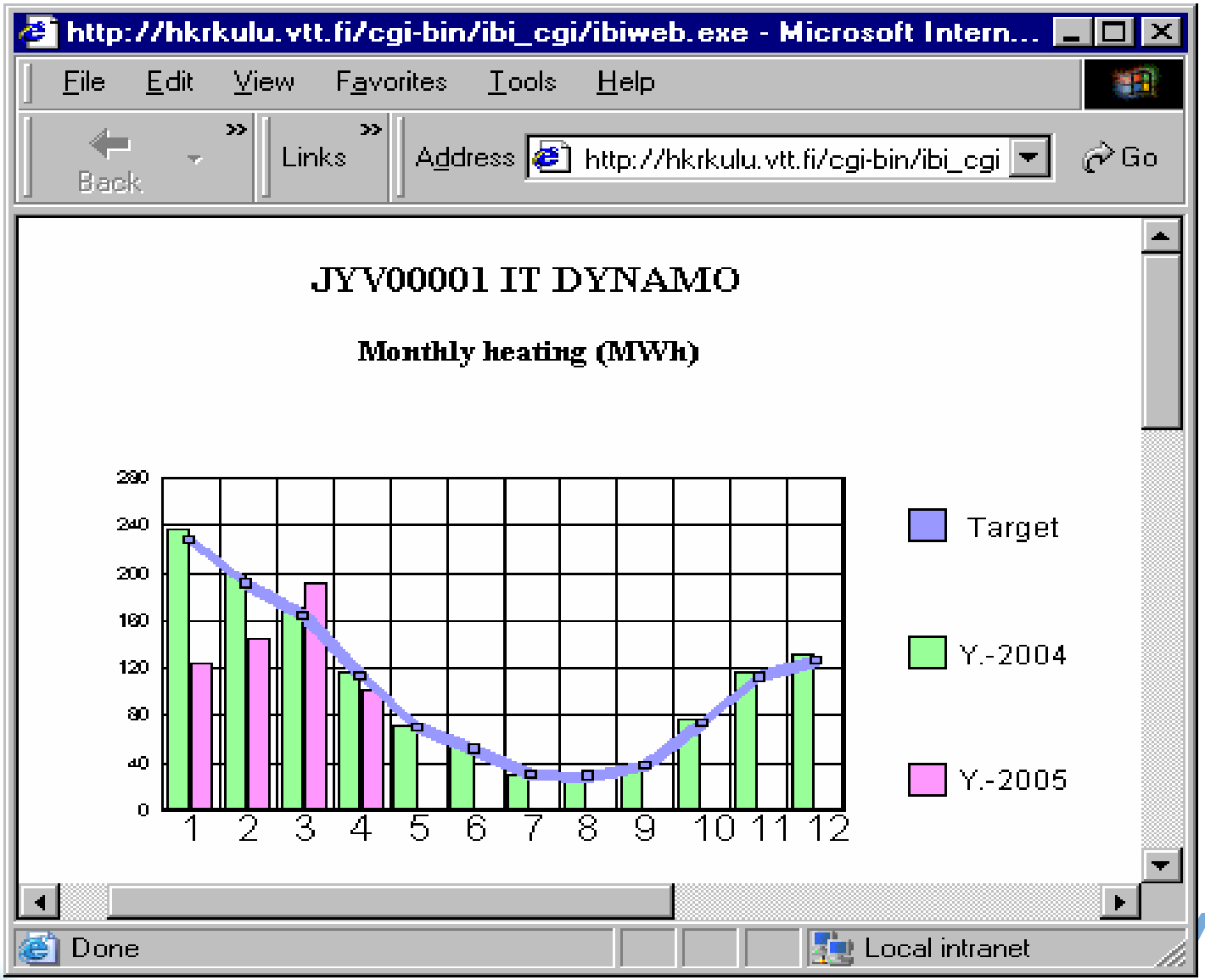
EA on Building Level:



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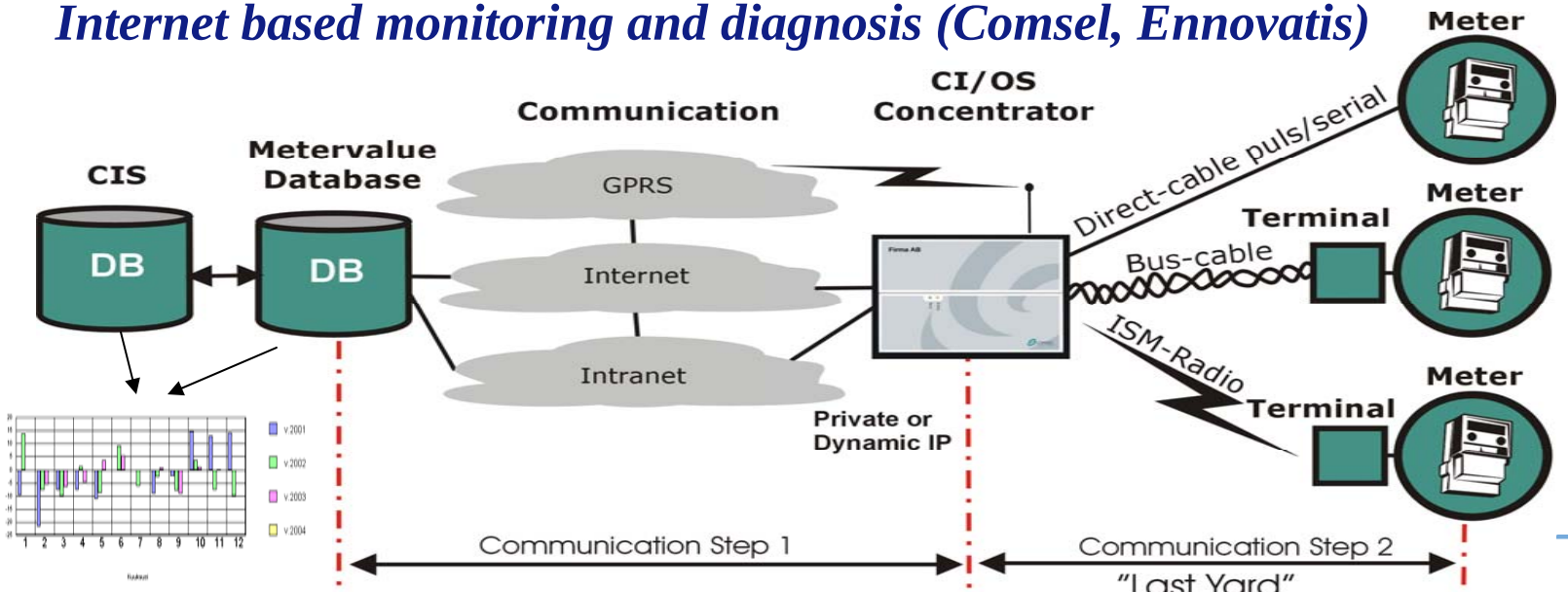
Demonstration of new tehcnologies?

SoapBox (VTTELE)

LUQAS-Smart Sensor (EnSan, GER)

Internet based monitoring and diagnosis (Comsel, Ennovatis)



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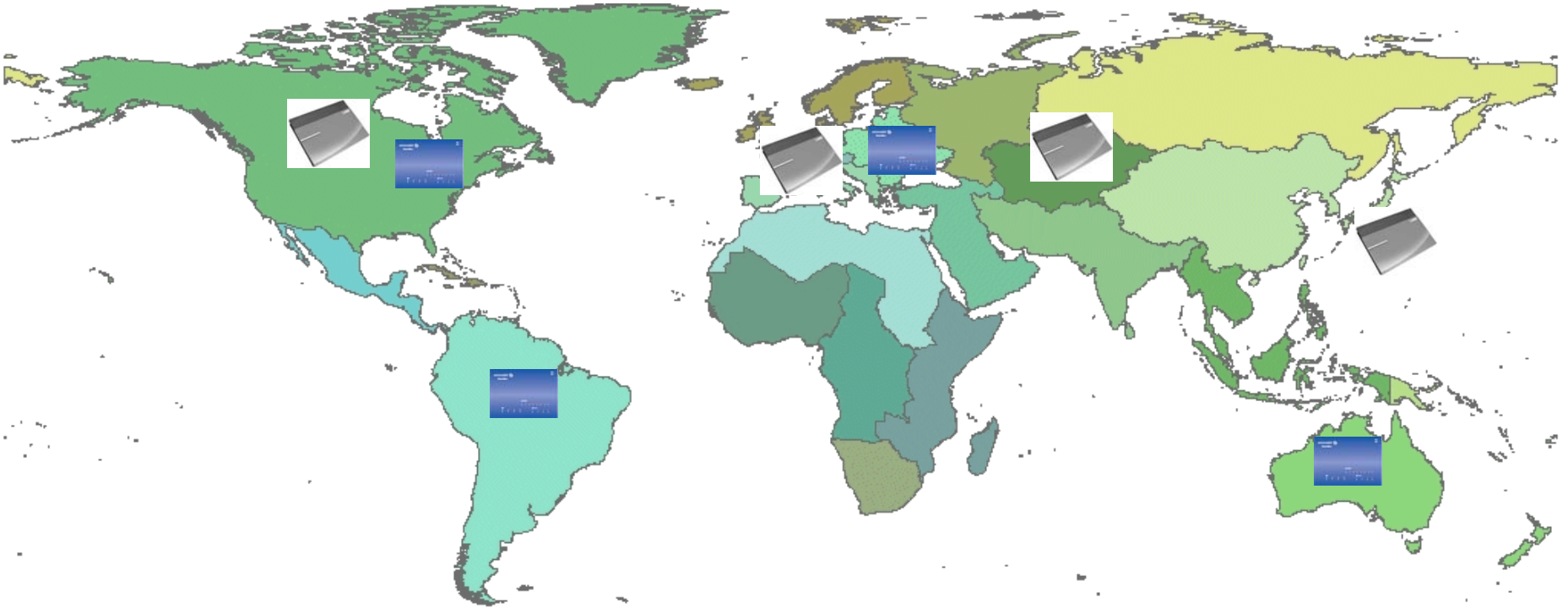
EnErGo Database



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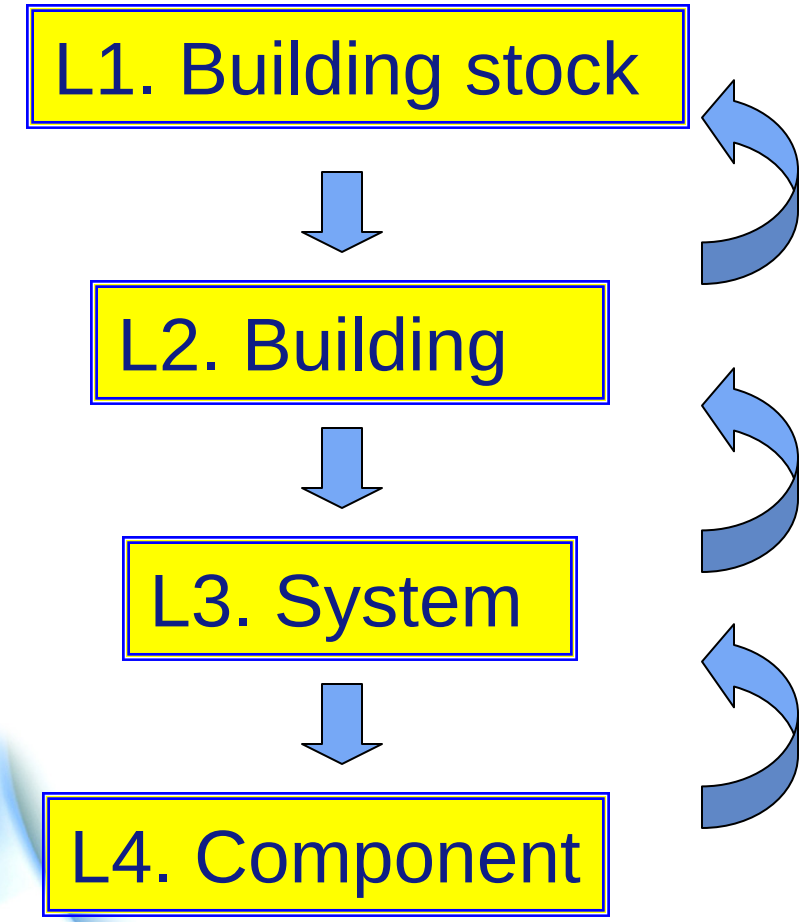
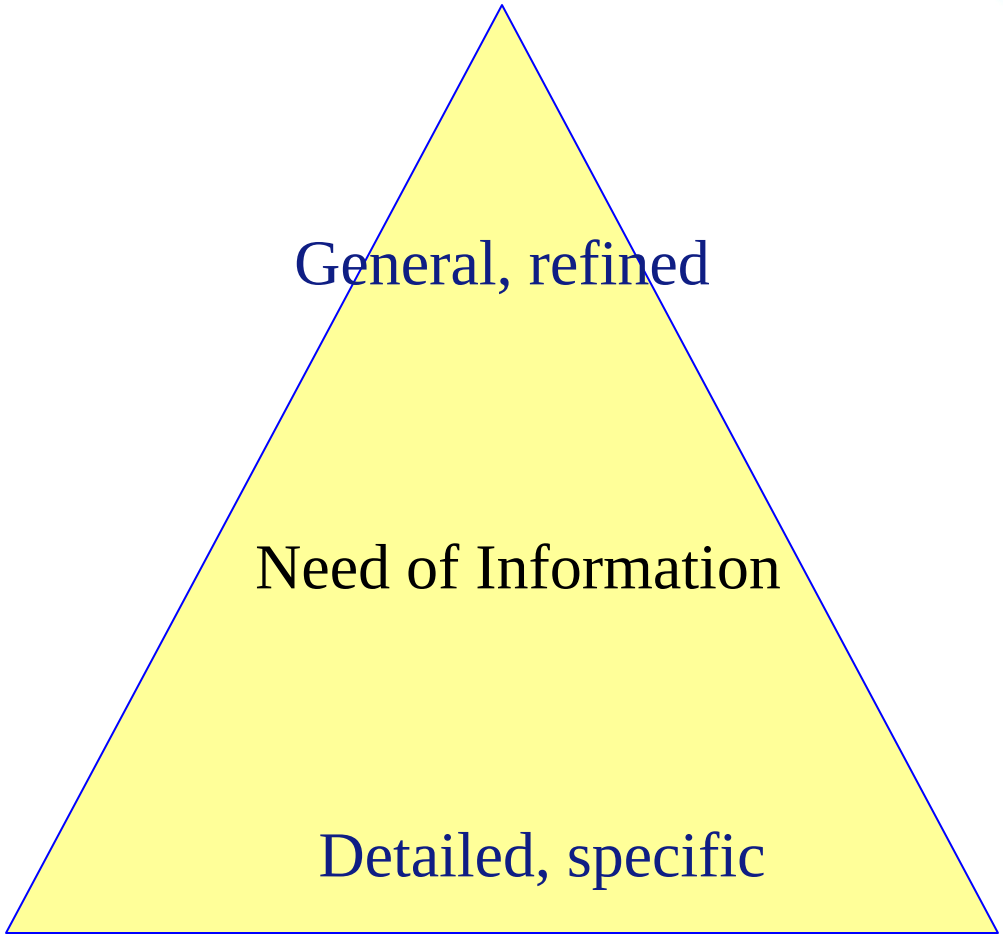
Tools of assessment:





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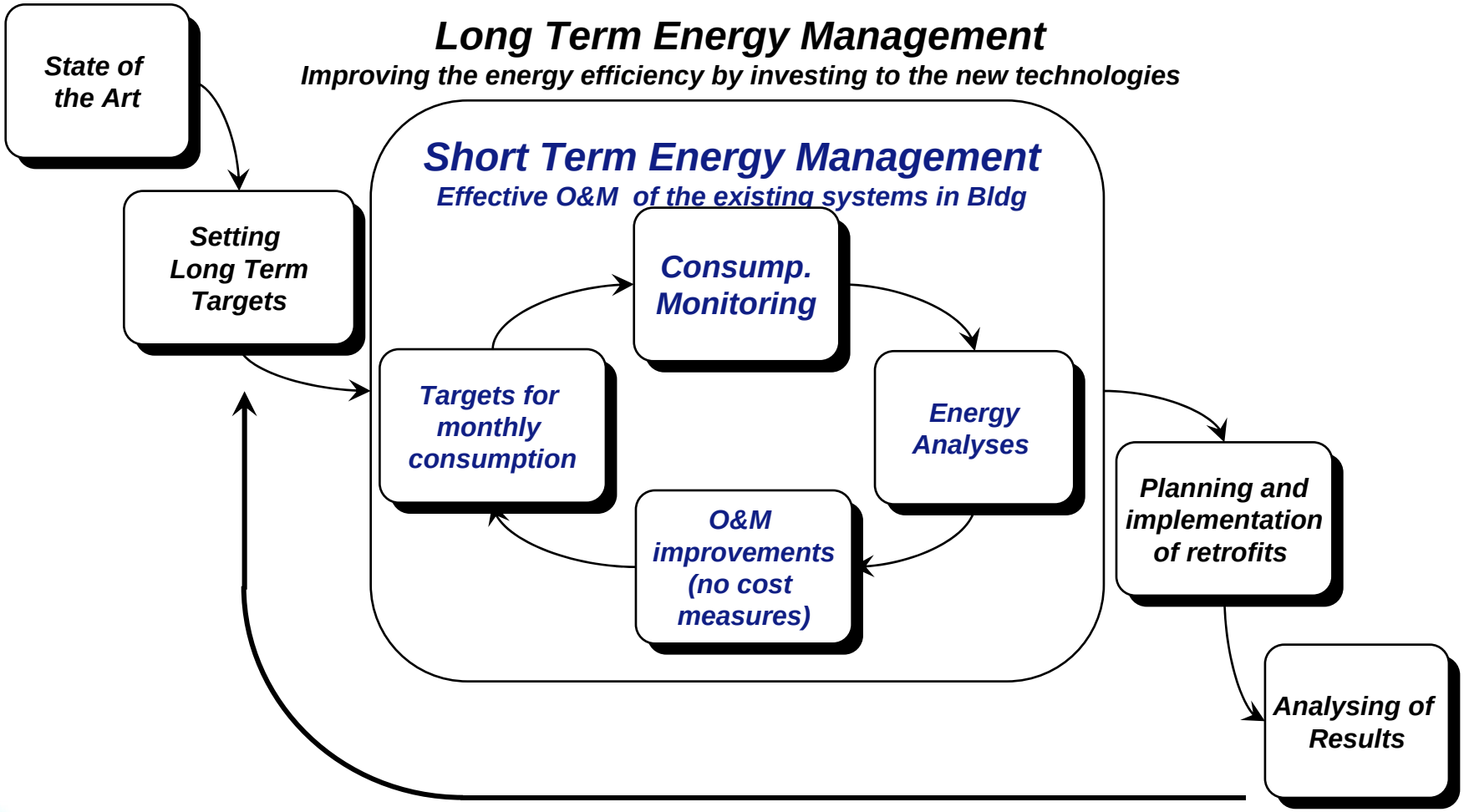
Enegy Management Strategies



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